AVIATION AND AERONAUTICAL ENGINEERING

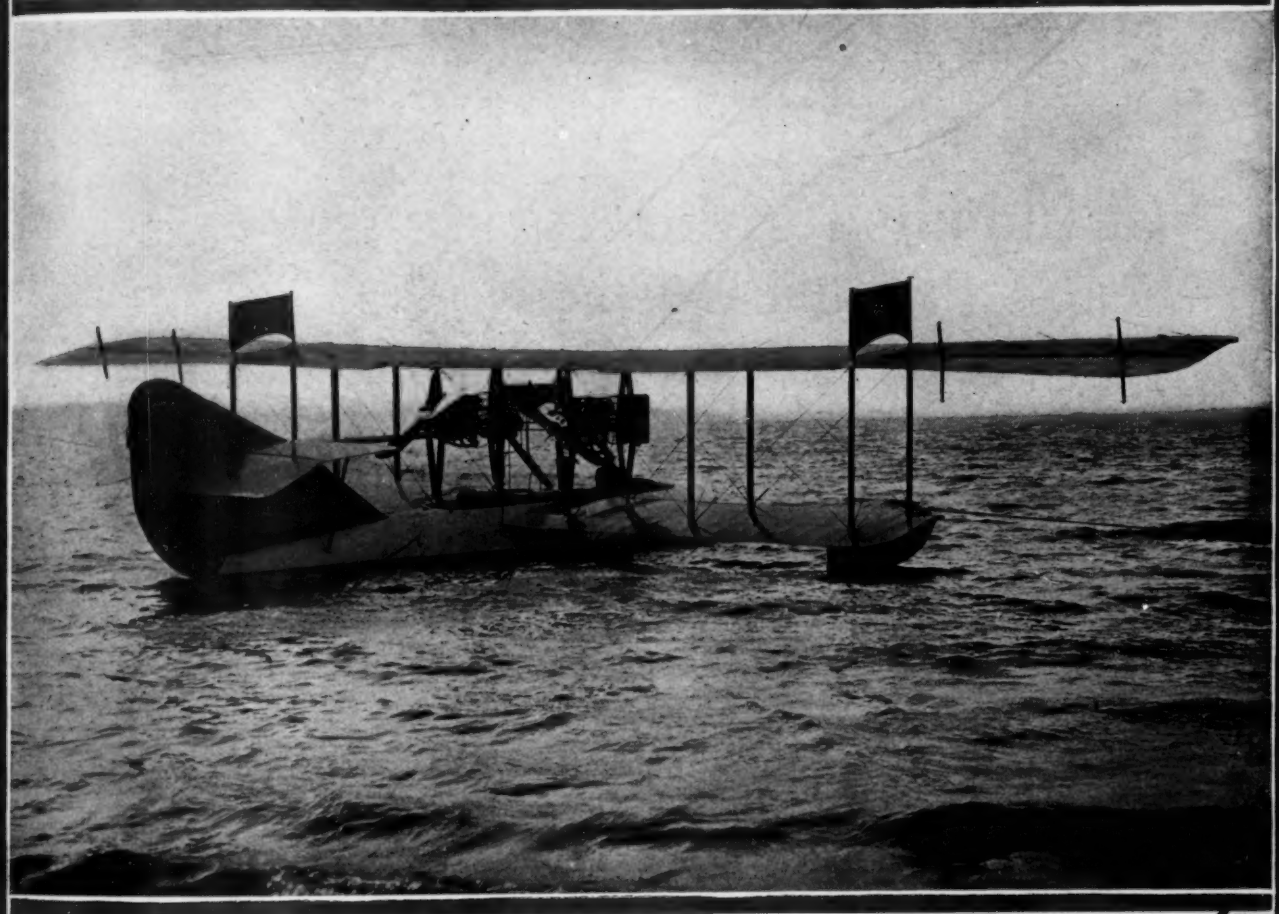


Photo by Underwood & Underwood

The Curtiss Five-Passenger Flying Yacht

DECEMBER 1st 1916

PRICE Ten Cents

SPECIAL FEATURES

TURNBUCKLES FOR AIRCRAFT

THE NEW NAVY DIRIGIBLE, DN-1

SCIENTIFIC RESEARCHES NEEDED ON AERONAUTIC PROBLEMS

CONSTRUCTION OF KITE BALLOONS

COURSE IN AERODYNAMICS AND AIRPLANE DESIGN

PUBLISHED SEMI-MONTHLY
BY
THE GARDNER, MOFFAT CO., Inc.
120 W. 32nd ST. NEW YORK

Indian Motocycle Hangars and Shop on the Border

14 Indians for the Aviation Section Signal Corps, U. S. A.

The Aviation Section of the United States Army Signal Corps has ordered, for use by the Aero Squadrons, fourteen 1917

Indian Motocycles

No greater tribute could be paid to the Indian's supreme power, speed, endurance, reliability, and general construction excellence.

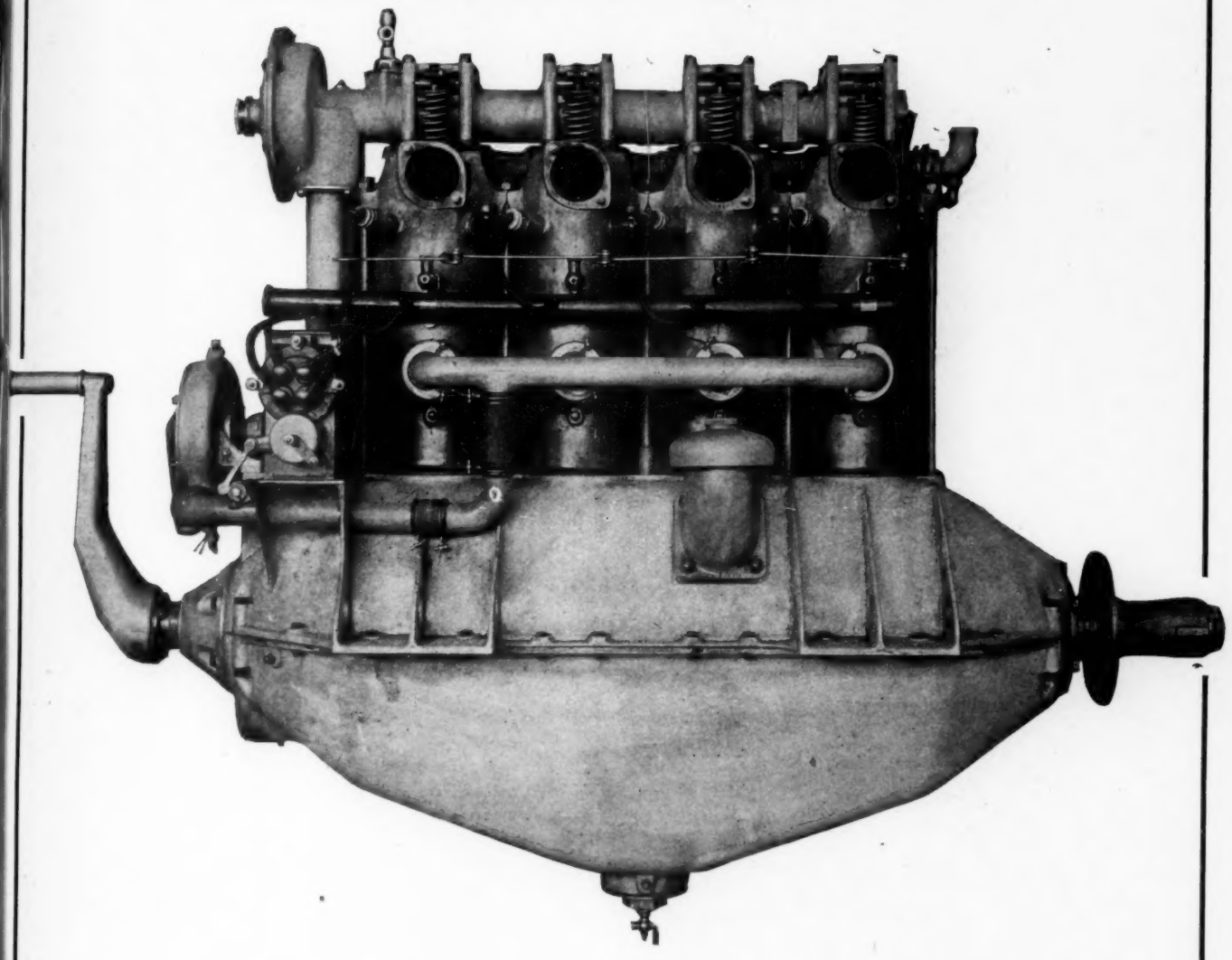
1917 Indian Catalog, illustrated and fully descriptive of Indian products, will be sent anywhere on request. It is a veritable textbook of the most advanced motorcycle construction.

HENDEE MANUFACTURING COMPANY

(Largest Motorcycle Manufacturers in the World)

SPRINGFIELD, MASSACHUSETTS

HALL-SCOTT



The Hall-Scott four cylinder, vertical, 90-100 H.P. equipment, has been especially built to meet the requirements for Army and Navy training and light scouting airplanes. The simplicity and sturdy construction of the engine, together with assurance of smooth and steady power output particularly adapts it for the use intended.

This engine is offered, after undergoing the regular series of running tests at the Hall-Scott Plant and satisfactory tests in airplanes under actual flying conditions.

Type A-7 : 90 H.P. *Type A-7a : 100 H.P.*

HALL-SCOTT MOTOR CAR CO., Inc.

General offices:---818 Crocker Bldg., San Francisco, Calif.

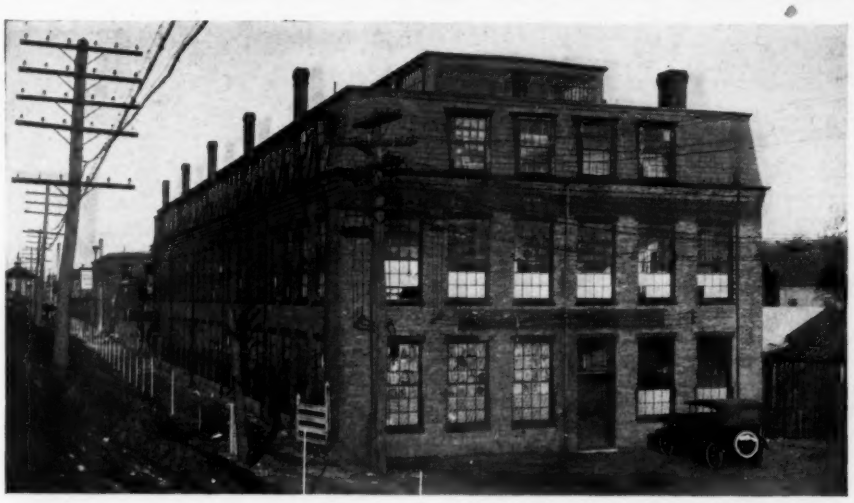
Eastern representative: F. P. Whitaker, 165 Broadway, N. Y.

Fifty Year

THE facilities of the B. F. Sturtevant Company for the design and manufacture of mechanical products are the result of fifty years of progressive expansion. The continual development of new lines and new application.

Sturtevant
(REG. U. S. PAT. OFF.)

f Progress



TO the American Aeronautical Industry, it brings unsurpassed plant equipment and an organization headed by experts and capable of producing superior airplanes and engines.

Sturtevant
(REG. U.S. PAT. OFF.)

WRIGHT-MARTIN A

Owns all the Stock of

The Wright Company
Glenn L. Martin Company
Simplex Automobile Company
Wright Flying Field, Inc.
General Aeronautic Company of America, Inc.
(*Export Company*)

Location of Plants

Western aeroplane factory
Los Angeles, Cal.
Eastern aeroplane factory
Site now being selected near New York
Experimental aeroplane factory
Dayton, O.
Aviation motor factory
New Brunswick, N. J. (*Simplex Works*)
Western flying field
Los Angeles, Cal.
Eastern flying field
Hempstead Plains, L. I.
Hydroaeroplane station
Port Washington, L. I.
Total men employed, 2362

Capital Stock

7% cumulative convertible preferred, $5,000,000
Common stock, of no par value, 500,000 shares

Officers

Edward M. Hagar, President
Glenn L. Martin, Vice-President
C. S. Jennison, Vice-President
James G. Dudley, Secretary & Treasurer
Gordon Wilson, Comptroller
A. H. Hudson, General Purchasing Agent

Counsel

Chadbourne & Shores, General Counsel
Fish, Richardson, Herrick & Neave, Patent Counsel

60 BROADWAY,

AIRCRAFT CORP.

Directors

Frederick B. Adams
Of Potter, Choate & Prentice

Frederic W. Allen
Of Lee, Higginson & Company

John F. Alvord,
President, Hendee Manufacturing Company

T. L. Chadbourne, Jr.
Of Chadbourne & Shores

Harvey D. Gibson
Vice-President, Liberty National Bank

Robert Glendinning
Of Robert Glendinning & Company, Philadelphia

David M. Goodrich
Director, B. F. Goodrich Co.

Edward M. Hagar
President, Wright-Martin Aircraft Corporation

C. S. Jennison

Henry Lockhart, Jr.
Goodrich-Lockhart Company

N. Bruce MacKelvie
Of Hayden, Stone & Company

T. Frank Manville
President, H. W. Johns-Manville Company

Glenn L. Martin
Vice-President, Wright-Martin Aircraft Corporation

S. F. Pryor
Vice-President, Remington Arms-Union Metallic Cartridge Company

W. Hinckle Smith
Of Philadelphia

Henry R. Sutphen
Vice-President, Submarine Boat Corporation

Harry Payne Whitney

Offices

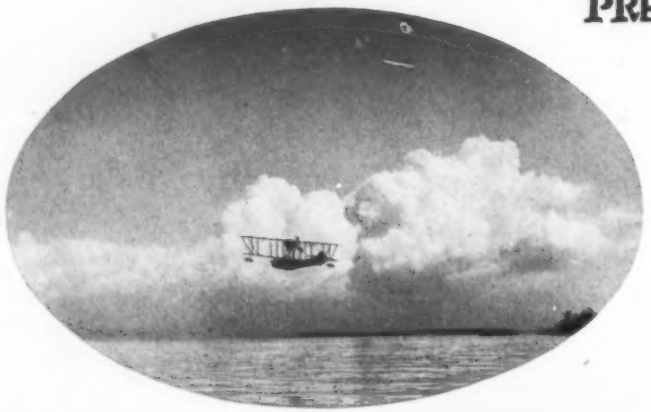
Main Office, 60 Broadway, New York City
Western Office, 937 S. Los Angeles St., Los Angeles, Cal.
Foreign Office, 35 bis Rue d' Anjou, Paris

NEW YORK CITY

THE NEW WATER SPORT OF THE SUPERMAN

Instruction
in a General Aeroplane Co's Verville Type Flying Boat will convert the ardent speed motor boat enthusiast to the virile man making sport of flying

"PREPAREDNESS"



Office — 1507 East Jefferson Ave.

GENERAL AEROPLANE CO.
Detroit U.S.A

Hangars Old Detroit Motor Boat Site

LAMINATED WOOD FUSELAGE

Aeroplanes and Hydroaeroplanes

ANNOUNCING OUR NEW FACTORY

60,000 FEET ON ONE FLOOR
60,000 FEET UNDER ONE ROOF

LAND AND WATER TESTING AND FLYING AT DOOR OF FACTORY

L-W-F ENGINEERING COMPANY

FACTORY:
College Point, Long Island
'Phone—Flushing 2300

Demonstrations by Appointment

NEW YORK CITY OFFICE:
5052 Grand Central Terminal Building
'Phone—Murray Hill 8974

THE CONNECTICUT AIRCRAFT COMPANY

NEW HAVEN CONN. U. S. A.

CONTRACTORS TO THE UNITED STATES ARMY and NAVY

MANUFACTURERS OF

Dirigibles Non-Rigid, Semi-Rigid and Rigid (Zeppelin) Types

Observation Balloons

Kite Balloons

Sport Type Dirigibles

Spherical Balloons of All Sizes

SPECIFICATIONS AND QUOTATIONS ON REQUEST

FACTORY and EXECUTIVE OFFICES
NEW HAVEN, CONN.

New York Office
303 FIFTH AVENUE

DECEMBER 1, 1916

AVIATION
AND
AERONAUTICAL ENGINEERING

VOL. I. NO. 9

INDEX TO CONTENTS

	PAGE
Old and New Types of Airplanes	280
Editorials	281
Turnbuckles for Aircraft	282
The New Navy Dirigible, DN-1	286
Scientific Research Needed for Solution of Aeronautic Problems	287
The Austrian D. F. W. Biplane	288
Aeronautical Patents	288
Construction of Kite Ballons	289
Course in Aerodynamics and Airplane Design	291
Book Reviews	293
News of the Fortnight	294
Miss Law Made Records in Chicago-New York Flight	294
The Navy Wants Seaplane Speed Scout	294
Squadron Flight from Mineola to Princeton	294
Bids for Army Hydroaeroplanes	295
Harvard Undergraduate Aero Training Fund	296
It is Reported That—	300

THE GARDNER, MOFFAT COMPANY, Inc., *Publishers*
120 WEST 32D STREET NEW YORK

SUBSCRIPTION PRICE: ONE DOLLAR PER YEAR. SINGLE COPIES TEN CENTS. CANADA AND FOREIGN: ONE DOLLAR AND A HALF A YEAR. COPYRIGHT, 1916, BY THE GARDNER, MOFFAT COMPANY, INC.

ISSUED ON THE FIRST AND FIFTEENTH OF EACH MONTH FORMS CLOSE FIVE DAYS PREVIOUSLY. ENTERED AS SECOND-CLASS MATTER, AUGUST 3, 1916, AT THE POST OFFICE AT NEW YORK, N. Y., UNDER ACT OF MARCH 3, 1879.

THE CREAGH-OSBORNE AIR COMPASS

—IS—

ACCURATE—

It indicates the North accurately.

RELIABLE—

Its accuracy is maintained whenever and wherever used.

SUBSTANTIAL—

It remains both accurate and reliable even under severest usage during any cross-country flight.

Dial visible by Day and Night

THE SPERRY GYROSCOPE COMPANY

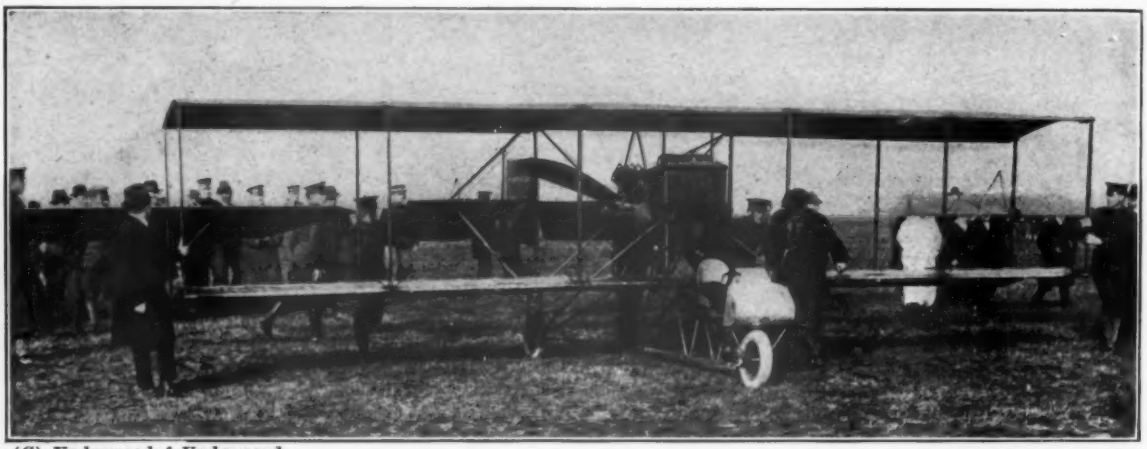
Manhattan Bridge Plaza **Brooklyn, N. Y.**

Telephone 9700 Main

Rue Boissy d'Anglas—10
Cité du Retiro, Paris

15 Victoria Street
London, S. W.

Old and New Types of Airplanes



(C) Underwood & Underwood.

The machine in which Miss Ruth Bancroft Law made the Chicago to New York trip is an old type Curtiss pusher specially built for Miss Law's looping exhibitions. The spread is 29 feet, and it carried only 53 gallons of gasoline.

(C) Central News.

Captured German airplane, probably of the Albatross type, with engine, hood and cockpit combing removed. The engine is a characteristic German six-cylinder type, installed with a view to extreme accessibility. Worthy of note are the exhaust gas collector on muffler, with pipe to deflect gases over top plane; German type radiator; gravity feed tank behind radiator; propeller with narrow tips. The hole in the body forward to give ventilation to the engine compartment, with a louvre on the side to let the air out, is also interesting, as showing standard German practice.

PRESIDENT AND EDITOR
LESTER D. GARDNER

MILITARY EDITOR
PHILIP J. ROOSEVELT

AVIATION AND AERONAUTICAL ENGINEERING

TECHNICAL EDITOR
A. KLEMIN, A.C.G.I., B.Sc., S.M.
Instructor in Aeronautics
Massachusetts Institute of Technology

MANAGING EDITOR
HERBERT M. WILLIAMS, B.S.

Vol. 1 | December 1, 1916 | No. 9

THE first naval dirigible balloon has been shipped to Pensacola. The Bureau of Standards, the National Advisory Committee for Aeronautics and the Naval Consulting Board are all enlisted in an effort to solve some of the engineering problems connected with the construction of large rigid types of dirigibles. Officers of the Navy, too, it is understood, have not been idle but are working at the "superzeppelin" balloon problem.

Another problem that is receiving the Navy's serious attention, is the development of a satisfactory seaplane speed scout. If the proper dirigible and scout can be found the Navy will be fairly well equipped as far as air service is concerned.

Confusion as to the function of the Naval air service appears to have arisen in many lay minds through a misunderstanding of the broad function which the Navy plays in the system of National defense.

The Navy's business is to bring superior force or strategy against any enemy fleet with a view to the capture or destruction of that fleet. With problems of coast defense it is practically not concerned, and commerce raids are of only secondary importance.

In the event of future war, orders would probably be issued to the American battle-fleet commander to capture or destroy the enemy fleet. The usual howl for protection would probably go up from every harbor, summer resort and ocean-side village, but the duty of the Navy's General Board would be to see that no ship of air or sea which might add to the strength of the battle fleet should be withdrawn from that fleet.

A trans-Atlantic enemy might reasonably be supposed to adopt a campaign along lines of commerce raiding in the North Atlantic coupled with a main blow at Guantanamo and the Panama Canal, or a feint at Guantanamo and the Canal and a real blow at our Atlantic seaboard.

The disposition of the enemy fleet would have to be learned to a certainty with the utmost possible precision while the enemy was still 2,000 miles away. The torpedo boat destroyer screen could tell the fleet commander much, later on, but giant dirigibles capable of conducting reconnaissance 2,000 miles from any base would alone serve to divulge the enemy's plans. At the present time, it seems impossible to conceive that heavier than air machines can be built with such a radius of action for some years to come.

Upon discovery of the main enemy fleet powerful wireless equipment might be used to inform the commander in chief of the enemy fleet's distribution and movements. Because of their bulky size, dirigibles, while indispensable, are not dependable in very high winds. The modern heavier-than-air machine will soon be developed to a point where it can scorn almost any hurricane. Therefore it is imperative that the battle fleet be accompanied by almost numberless little seaplane speed scouts for interference with enemy dirigibles and for fighting enemy aircraft.

These machines could attack dirigibles like kingbirds attack hawks with excellent chances of success, and they being ever present with the battle fleet aboard a tender could render a great service by giving immediate information of an invaluable character in regard to enemy tactics after battle was joined. Especially would they be necessary in weather when dirigibles were incapable of effective operation.

It is a safe premise that no enemy will attempt to land on our shores as long as we have a fleet in being. The function that the Aviation Branch of the Navy Department is considering is how to increase the efficiency of our main battle fleet. If that fleet should be defeated any war in which we might become engaged would practically be ended so far as the Navy Department was concerned. Then it would be the Army's turn, for all our coast defense fortifications are under the War Department's control. It is the War Department's duty to prevent a landing on our shores and the bombardment of our seaport towns and it is for this purpose that the Army is about to buy a large number of twin-motored seaplanes.

Miss Law's Remarkable Accomplishment

In a little exhibition airplane modeled after those of three and four years ago, Ruth Bancroft Law has established a new American non-stop distance record of 590 miles. Her flight is a great personal achievement. In a machine of antiquated type, without elaborate navigating accessories and lacking experience in cross-country flying, she has established a new American cross-country distance record. It is an achievement of which any one might well be proud.

Victor Carlstrom whose record she broke paid a sportsmanlike tribute to her when he said: "Her flight is the best performance to date in American aviation, and mighty few European fliers have bettered it. Miss Law has shown us all the way and set the mark at which I for one will be glad to shoot."

To Miss Law, AVIATION AND AERONAUTICAL ENGINEERING extends most sincere congratulations. With rare skill, pluck and daring she has surprised the public with a remarkable feat, that is bound to stand out as one of the brilliant achievements in aeronautical progress.

Turnbuckles for Aircraft

By Arthur Orr

This article discusses only turnbuckles used in aircraft. They are such small and inconspicuous parts of an airplane that their importance is usually overlooked, but no element in an airplane is more vital. In double wired machines the breakage of one turnbuckle may not have serious results, but in single wired machines one failure often means the loss of a plane and its occupants. Double wiring is already on the wane in Europe, and with increasing speeds and higher efficiencies it will no doubt gradually disappear in this country, increasing the importance of the turnbuckle still further. Perhaps no metal article so small and simple is as difficult to produce in a commercial way as a high grade turnbuckle.

PROPERTIES

The properties of a good turnbuckle, ranked in the order of their importance, are uniformity, toughness or resistance to fatigue, strength in proportion to weight, take-up in proportion to weight, projected area in proportion to weight, durability, and cost. We purposely omit finish or appearance as such, for it may be assumed that a turnbuckle which in theory and practice is found to be excellent will sooner or later be considered good looking.

Uniformity is put first because turnbuckles must, above all else, be dependable, although in practice a certain tolerance is naturally allowed. In fact, if A makes 1,000 turnbuckles of which 999 break over 1,000 pounds, and the other one at 400 pounds, owing to a hidden defect, and B produces 1,000 turnbuckles of which 900 break over 1,000 pounds, and the rest over 950 pounds, B's turnbuckles are evidently preferable. Lack of uniformity has various causes which will be treated separately.

Toughness or resistance to fatigue is almost equally important, but we find constructors who overlook this fact as shown by their acceptance tests which often involve only dimension, fit and a straight pull. Such a test gives ultimate tensile strength but does not throw any light on the ability of the turnbuckle to stand up under combined vibration and stress.

With increasing speeds the question of projected area becomes more important, and every effort is being made to produce turnbuckles which, while possessing other necessary properties, are so small in bulk and easy in line as to cause minimum head resistance.

The properties mentioned above depend on design, material, method of manufacture and finish. In designing a turnbuckle, the strength required is taken as the starting point. The take-up of a turnbuckle, which depends primarily on its length, cannot be figured theoretically, but must be based on practice and experience. Turnbuckles in a short stay, where the wire or cable has small opportunity to stretch, and where the members connected are likely to be rigid, require less take-up than long spans, but it is a great mistake to use turnbuckles which do not provide far more take-up than is theoretically necessary.

The constructor who turns out many machines of a type, and whose practised workmen, with their factory facilities, are able to cut and splice or connect cables and wires with great accuracy, is apt to forget that, although the allowance for personal margin of error in this case can be very small (thus leaving all the take-up for subsequent expansion or contraction in the finished stay), the machine when it leaves his factory and goes into the field may need a repair involving the fitting of a new stay. The mechanic who hurriedly makes this repair in the field is very sure to require a greater take-up margin than the factory specialist. Turnbuckles in control cables should always have a particularly generous take-up.

As it is advisable to reduce types and sizes of turnbuckles to a minimum, constructors should therefore allow a wider margin of contractibility than is necessary to cover tolerance in fitting wires at the factory, plus sufficient provision for subsequent wire or cable stretch and deformation in the finished aeroplane, and should try to use only one length of strainer for a given load. Many flyers obliged to fit new wires when the take-up of a strainer is exhausted have cursed the constructor for not providing more contraction.

TYPES

In this article, we shall refer to the central part into which are threaded the left and right hand bolts respectively as the barrel, and to the separate ends as stems. The end of the stem through which the cable passes is called the eye. When this end is split or slotted, we shall refer to it as a forked eye or forked end. We will not take up the question of stems for special fittings, such as ball and socket joints, siamese stems, etc., as their use is very limited.

Several unusual types of turnbuckles have been produced at one time or another; such as those made with bent bicycle spokes, in which a nut bearing against a flat loop was screwed up to tighten the wire. A very good turnbuckle was produced in France in which the cable was fastened to an eye on the end of an internally threaded tube. A second smaller tube, threaded both inside and outside engaged the internal threads on the larger tube, while its internal threads in turn engaged a stem to the opposite end of which the other cable or fitting was attached. Turning the smaller tube separated the eyes or brought them together as the case might be. Another type sometimes used is one in which the internal threads are on the cable terminal and the fitting, and the external right and left hand threads on opposite ends of a rod which engages each of these ends.

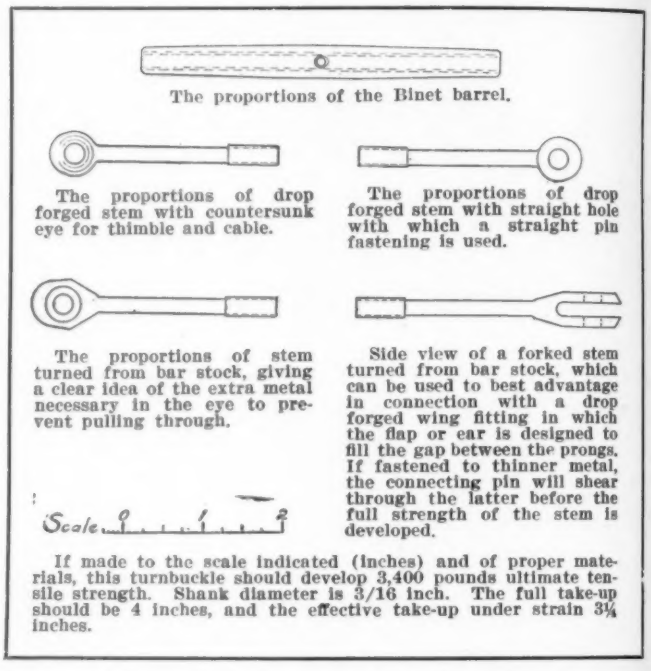

The proportions of the Binet barrel.
The proportions of drop forged stem with countersunk eye for thimble and cable.
The proportions of drop forged stem with straight hole with which a straight pin fastening is used.
The proportions of stem turned from bar stock, giving a clear idea of the extra metal necessary in the eye to prevent pulling through.
Side view of a forked stem turned from bar stock, which can be used to best advantage in connection with a drop forged wing fitting in which the flap or ear is designed to fill the gap between the prongs. If fastened to thinner metal, the connecting pin will shear through the latter before the full strength of the stem is developed.
Scale 0 1 2
If made to the scale indicated (inches) and of proper materials, this turnbuckle should develop 3,400 pounds ultimate tensile strength. Shank diameter is 3/16 inch. The full take-up should be 4 inches, and the effective take-up under strain 3¼ inches.

FIG. 1. BARREL AND STEM PROPORTIONS.

Attempts to use special wires or rods, upset and threaded at the ends which engage directly in the barrel, thus eliminating stems and stem fastenings, have not yet been successful. As all these types have a very limited use, our remarks will be confined to the conventional form. The usual method of locking turnbuckles with soft wire is simple, light, dependable and inexpensive, and as lock-nuts cannot be used except on the old fashioned fully threaded stem, they are not employed in modern practice.

DESIGN

The eye of a turnbuckle must be so designed as to provide ample strength. If it is intended to take cable, the hole should be of sufficient diameter to allow for a thimble and it should be smoothly countersunk on both sides so there will be no tendency to cut or wear the inside bend of the thimble at any point. If the eye is to take a solid wire without thimble, it should be elongated and thickened at the end where there is a tendency to wear, owing to the sawing effect of the hard tempered wire. This elongation also prevents too abrupt a loop in the wire, which would tend to fracture it.

The shank of the stem should be unthreaded for most of its length, the length of the threaded end amounting to about three diameters. This feature was originated and patented by Alphonse Binet, but is now widely copied. The advantages are that a mechanic may easily check up the wiring, as he need only be sure that no threads are exposed. With stems completely threaded there was no simple way of telling whether two threads or fifteen threads were engaged, and where the latter might have been safe, the former would have stripped under flying load. In addition, the threaded portion is protected from the weather, and holds its oil, thus preventing rust. The smooth, unthreaded portion of the stem is easier to keep painted and clean; it will also bend without fracture far more readily than a threaded stem, and as the same number of stem threads are always engaged, fit does not become tighter as the stem is screwed in.

Threading, if very fine, is apt to strip and allows too small a tolerance in the fit. Coarse threads are proof against stripping, but produce a weak stem and barrel in proportion to their weight. The form of thread should be U. S. Standard and the following table shows the proper ratios:

Diameter of unthreaded shank.	Number of threads.
About 1/8 inch.	About 34 per inch.
" 5/32 "	" 32 " "
" 3/16 "	" 26 " "
" 1/4 "	" 22 " "

Barrels are made of round rod with a cross hole bored at the center, for expanding or tightening the turnbuckle, and tapering from near the middle to both ends. The central portion for about ¼ to 1/3 the total length of the barrel should be left full size. The tapers should be such that the strength of the barrel at all points is above the ultimate strength of the stems. Some barrels are insufficiently tapered, thus uselessly increasing weight and head resistance, but more often we find barrels in which the taper is too abrupt, thus producing a barrel which will break near one end when the turnbuckle is extended.

Barrels turned out of hexagonal or octagonal rod are not desirable, as it is far easier to turn the barrel with a nail or piece of wire than with a wrench which is clumsier to use and which wears away the corners on the small hexagon portion.

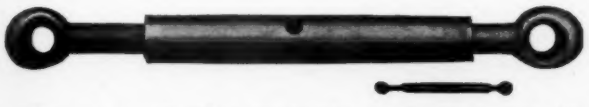
Some British Admiralty barrels are turned out of oversize rod, allowing enough material to leave a reinforcing ring of metal at the center, through which the cross hole is drilled. This extra section is necessary when the cross hole is unusually large, as may be required for exceptional uses. French and other continental constructors, however, do not want this center ring which has the disadvantage of increasing weight, head resistance and cost. A hole amply large enough for twisting the barrel does not require the removal of enough metal to reduce the strength at the center of the barrel below the strength near its ends.

The question of fit is one about which there has been much discussion. The dangers to be avoided are stripping at heavy load and wear in the threads as a result of vibration under tension when the fit is too loose. But years of experience, as well as many tensile tests, indicate that, within certain limits, a loose fit is in practice safer than a very tight fit. The wear due to screwing and unscrewing a turnbuckle and from vibration under strain is almost negligible, providing the bronze barrels and steel stems are of proper material and are kept free from sand and grit. In fact the fit of any stem is apt to become tighter with service, owing to thickening and oxidation of the oil or varnish with which the stems are protected.

The danger of using a tight fit is that this initial tightness may increase, owing to the above causes and hidden rust, to such a point that on turning the barrel the stems will be twisted rather than turn in their threads. A mechanic hastily adjusting a small turnbuckle, particularly in cold weather when he may be wearing heavy gloves, can very easily make one or two turns without noticing that the stems are being twisted. If they break, delay only is the result; but if they twist without breaking, their strength may be so reduced as to leave no margin and an accident follows. If the fit is such that no strippage occurs when only ½ of the threaded portions of the stems are engaged in the barrel, it is amply safe. This point will be considered further under tests.

Streamlined barrels and stems designed to take streamlined or R. A. F. wires are beyond the scope of this article, as their use is necessary only on planes of higher speeds than are reached in this country.

All-steel Nieuport turnbuckle. Length of barrel 4⅝ inches. Tensile strength 11,000 pounds.



Large and small Binet turnbuckles. Barrels 5⅛ and 1⅝ inches long. Strengths 22,000 pounds and 400 pounds.

Binet type forged stem for wire in both eyes.

Binet turnbuckle connected to bolt by ball and socket joint, thus enabling stem to lead off at proper angle without tendency to bend.

English type bronze barrel 4 inches long, with machined ends. Tensile strength, 8,500 pounds. Note extra metal in eyes.

Binet No. 325.

Binet type forged stems, left hand with cable thimble, right eye to take pin.

"Nain-Géant" French strainer in which contraction and expansion are obtained by turning hexagonal end of threaded tube.

FIG. 2. SOME GOOD FOREIGN DESIGNS.

MATERIALS

Turnbuckles have been made of various metals and alloys. The standard practice of using bronze for the barrels and steel for the stems is so firmly established, however, that we will not consider other materials. Stems should not be made of cold rolled steel because of its low strength and lack of uniformity, both in purity and composition; nor will heat treatment improve it, although cold rolled or cold drawn steel has been used very considerably for stems, owing to the ease with which it can be worked.

Three and one-half per cent nickel, chrome vanadium and other high grade alloys are the only metals that should be considered for this work. Where cold rolled shows only about 60,000 pounds per square inch, these higher grade alloys can

safely be counted on for 120,000 to 140,000 pounds, combined with even greater toughness, elongation and reduction of area than is possible with cold rolled. In any case, steel should be selected only after careful tests, and stems should continually be broken to make sure that the raw steel itself, and particularly the stems after heat treatment, are giving uniform results. If stems are turned from solid stock, both ends of each rod should be examined for piping.

Bronze for the barrels should be of high grade, similar to Tobin bronze. Manganese should be avoided unless frequent and thorough tests are made to insure uniformity. In manufacturing on a commercial scale, this is an expensive item, and it is better to use a uniform tough bronze showing plenty of elongation than a manganese bronze with perhaps 5,000 pounds more tensile strength but far less uniformity.

The barrels are usually turned from solid round rod, but as drilling long true holes in very tough bronze is an expensive, troublesome process, one maker in this country has made barrels out of a specially drawn tubing in which the internal diameter is much less in proportion to the full diameter than had heretofore been produced. The hole is lightly reamed and tapped. As the drawing process leaves a dense skin both on the outside and inside surfaces, this process produces a barrel which has greater resistance to stripping than one turned out of solid rod, while the necessary elongation is fully maintained.

METHODS OF MANUFACTURE

Stems can be turned out of solid rod on hand or automatic machines or a combination of both, or they can be drop forged. Each has its advantages and disadvantages. Machined stems have a bright, smooth finish which makes them prettier to look at. Forged stems, if left with the natural skin, have a rougher appearance, but this skin tends to prevent rust, and produces a tougher, denser surface. Perhaps the greatest advantage of forged stems is that the fibres of the metal follow the contours in the eye, thus eliminating all danger of the wire tearing out. In stems turned from rod this risk is so great that foreign governments require a portion of each end of every rod to be tested to make sure that it has no pipe; but until inspection in this country has been standardized it is to be feared that turnbuckles for domestic consumption will not always be so carefully watched and it is thus advisable to choose reliable processes which do not depend too much on expensive manufacturer's tests.

Steel may be used in forging of a quality so tough that it cannot be satisfactorily machined even in its annealed state, particularly as the size and shape of stems make them difficult to hold. Thin, unsupported stem shanks are at best troublesome to turn unless the material cuts freely. Heat treating of forged or machined stems is equally important and delicate and should be so controlled that over-heating cannot occur.

In order to lessen danger from piping, British designs for machined stems call for an eye in which there is a great excess of metal. This precaution, considered necessary in spite of rigid tests and inspections, increases weight and head resistance, both of which can be kept to a minimum only by using drop forgings.

The need for rapid production on a large scale and the scarcity of skillfull forgers experienced in such small sizes explain their choice of this method. Although shank variation in forged stems is slightly more than in carefully machined stems, for if the forging is properly done, this variation is so reduced that it is more than counteracted by the beneficial effect of the hammering.

A more elaborate process used only by Binet in France is a combination of machining and forging, which largely overcomes the disadvantages of each. In this process the shank of the stem is fully machined while the eye is only partially machined and then reduced to size and shape by hot forging, finally being machined all over. Only his output of about 12,000 per day makes this process practicable.

Barrels can be finished on hand screw machines and automatics. To drill a small true hole of the necessary length in solid rod, preparatory to threading, is troublesome and impracticable with the toughest alloys. Bronze of this quality can only be used in a commercial way in the shape of drawn tubing which merely requires light reaming before threading, as above mentioned. Threads both on the barrels and stems should be cut in two or three stages, and even with this precaution the stems must be assembled and adjusted by hand to get the best fits.

FINISH

Providing the design, material and workmanship in a turnbuckle are good, no effort need be made merely to improve its looks. Additional finish, however, is often due on the eyes to insure a smooth bend for the wire or cable passing through it. This work is more difficult with forgings than on machined stems, owing to their tough skin which quickly dulls the cutting tool. Some of these operations are done by grinding both with hard and set-up wheels, etc.

The barrels are usually left in their natural state. If polished and lacquered they look very pretty for a short time, but experienced constructors omit this useless detail. Stems, however, may with advantage be given some coating which will increase their resistance to rust. This can either be of metal or in the nature of paint. Copper or nickel plating, or a combination of both, have been found unsatisfactory. Tinning is better, but the most practical and durable finish is undoubtedly electro-galvanizing if properly applied.

Any process which involves heating over 500 degrees F. even though theoretically insufficient to effect the heat treatment, should be avoided, thus sherardizing or hot galvanizing are not recommended. Lacquer, varnish, baking enamel or bitumastic solution can be applied either to the unplated stem or preferably to the stem which has already been galvanized. In galvanizing, care should be taken not to injure the surface in preliminary acid washing baths, and particular care must be taken in working the plated threads into the barrels.

COST

Cost naturally depends on the materials used, the process and the quantity of production. Barrels of easy cutting bronze, if produced in large quantities, are the cheapest, as they can be made on automatics out of solid rod. If the toughest bronze is used, however, tubing is necessary.

The relative cost of stems turned out of solid bar, as compared with forged stems, depends on the quality of the steel used, the output and the design. As already stated, some steel alloys admirably suited for stems are so tough and difficult to machine, even when annealed, that making them by this process becomes unprofitable, as the proportion of stems damaged in machining is too great. When the production of each size is large and thoroughly standardized, and it is permissible to use a steel which is easily machined, this process is cheaper than forging.

If, however, the toughest, strongest alloys are specified, drop forging must be chosen. This process requires skill and experience. As forging a small stem takes as much time, and if anything greater care than a large one, the labor cost is the same for each, thus making the small sizes proportionately more expensive than the large sizes, as compared with machined stems. Correctly forged stems are put through several sets of dies, requiring several reheatings to give uniform dimension and roundness in the shank.

TESTS

Before adopting a turnbuckle of standardized make and pattern, the constructor should subject it to a variety of tests covering its various properties. Several of these such as weight, length and head resistance of projected area will not vary beyond insignificant limits in a given batch and tests for these items need not be repeated. But on subsequent orders for the same turnbuckles, routine inspection tests involving less time and care should be made with a small percentage of the turnbuckles received to make sure that their uniformity, size, toughness and strength are up to standard.

Some foreign governments require destruction tests of from 8 to 10 per cent of all turnbuckles delivered. This is not necessary and we suggest the following inspection test which, while simple and positive, is even more searching than these extravagant foreign tests: On receiving a batch of turnbuckles, they should be carefully looked over and those which appear below standard, either as to size, fit or otherwise, should be laid on one side. Of these less perfect turnbuckles, the worst examples are taken for testing. Ordinarily, the number destroyed need not amount to more than 1 or 2 per cent of the total. Four things to be verified are: (1) tensile strength;

(2) danger of stripping; (3) defect in the eye; (4) toughness.

The turnbuckle with the loosest fit and most undersized shank is extended until one-half of the threaded portion of each stem is exposed, thus leaving only half of the threaded portion on each stem engaged in the barrel.

If the eyes are suspected, they should be enlarged about 20 per cent by drilling or reaming. Solid wire loops are then passed through each eye and the wire ends gripped in the upper and lower jaws of a Riehlé or other pulling machine. Wire amply strong enough to break the turnbuckle should be used, which is always possible when the eye is enlarged. The eyes should not be gripped directly in the jaws as this would afford no test of their strength or freedom from pipe.

The machine is then started at a uniform rate of travel, say one inch per minute. Ultimate tensile strength is noted, as well as the shank diameter near the break. If the turnbuckle breaks in one of the shanks between the eye and the threaded portion at or above its rated strength, it is satisfactory as regards strength, fit and eyes, for it is evident that in addition to its strength being up to standard, it is also proof against stripping. If the easiest fit in a batch of turnbuckles will not strip under full breaking load when only one-half of the available threads are engaged, there is no possibility that any of the other turnbuckles will strip when their tighter fitting stems are fully engaged. This is particularly true when it is remembered that the last two or three threads in the barrel are slightly over-sized in diameter, owing to the entering and drawing out of drilling, reaming and tapping tools which leave these last few threads slightly larger than the rest of the bore where these tools have better support.

This test for stripping is more exacting and conclusive than attempts to measure the degree of looseness in the fit. In fact, a fit may be tight because of imperfect threading, a slight bend in the shank, or several other defects which increase the danger of stripping. The eyes may be considered safe, as even enlarged they have held up without deformation or tearing under maximum load.

To determine toughness, the unbroken stem of the above turnbuckle is screwed into the barrel to a point at which all its threads are just engaged. The eye is then gripped in a vise with its shank pointing up, and the barrel is bent across the vise jaws through an angle of 90 degrees. The force for this bending is applied by hand at the top of the barrel opposite the stem and should act along a tangent to the arc described by the barrel. From its horizontal position, the barrel is then pushed back up to vertical and on past this point to an angle of 90 degrees on the other side. This bending is continued back and forth until the stem breaks.

The number of bends before breakage is a satisfactory measure of toughness and ability to resist fatigue. For turnbuckles of conventional pattern, having about one inch take-up and ½ ounce weight per 800 pounds tensile strength, the following performance can be demanded:

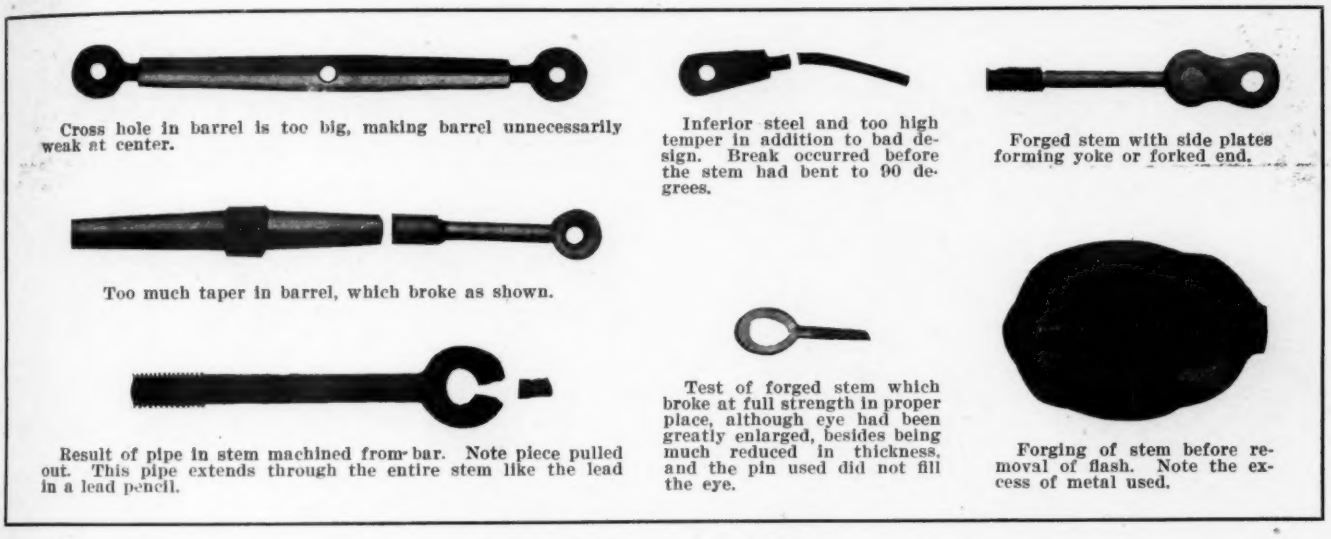
Tensile strength per square inch: 130,000 pounds.

Bending test: one 90 degree bend, plus two 180 degree bends, plus one 90 degree bend.

Shorter stems will stand less, longer stems proportionately more bending. These requirements may seem excessive, but as a matter of fact they are actually exceeded by one or two of the best makers.

A test made in this way is far more practical than separate experiments with the unfinished steel and bronze of which the turnbuckle is to be made. It must be emphasized that data covering elastic limit, ultimate tensile strength, reduction of area, elongation in a certain number of inches, etc., of raw materials do not give positive information regarding the finished article into which they are subsequently made, any more than analyses of flour and water would give exact information of the resulting bread. It is impossible to make good bread with bad flour, but it is easy to make bad bread with good flour.

Of the many turnbuckles used in a machine, it is the least perfect which is most likely to fail. An effort should therefore be made in testing to pick out the poorest specimen and even to reduce its strength in suspected parts, so that its showing, if successful, may be taken as proof that the other turnbuckles in the same batch, working under more favorable conditions, can be fully trusted.



Cross hole in barrel is too big, making barrel unnecessarily weak at center.

Too much taper in barrel, which broke as shown.

Result of pipe in stem machined from bar. Note piece pulled out. This pipe extends through the entire stem like the lead in a lead pencil.

Inferior steel and too high temper in addition to bad design. Break occurred before the stem had bent to 90 degrees.

Test of forged stem which broke at full strength in proper place, although eye had been greatly enlarged, besides being much reduced in thickness, and the pin used did not fill the eye.

Forged stem with side plates forming yoke or forked end.

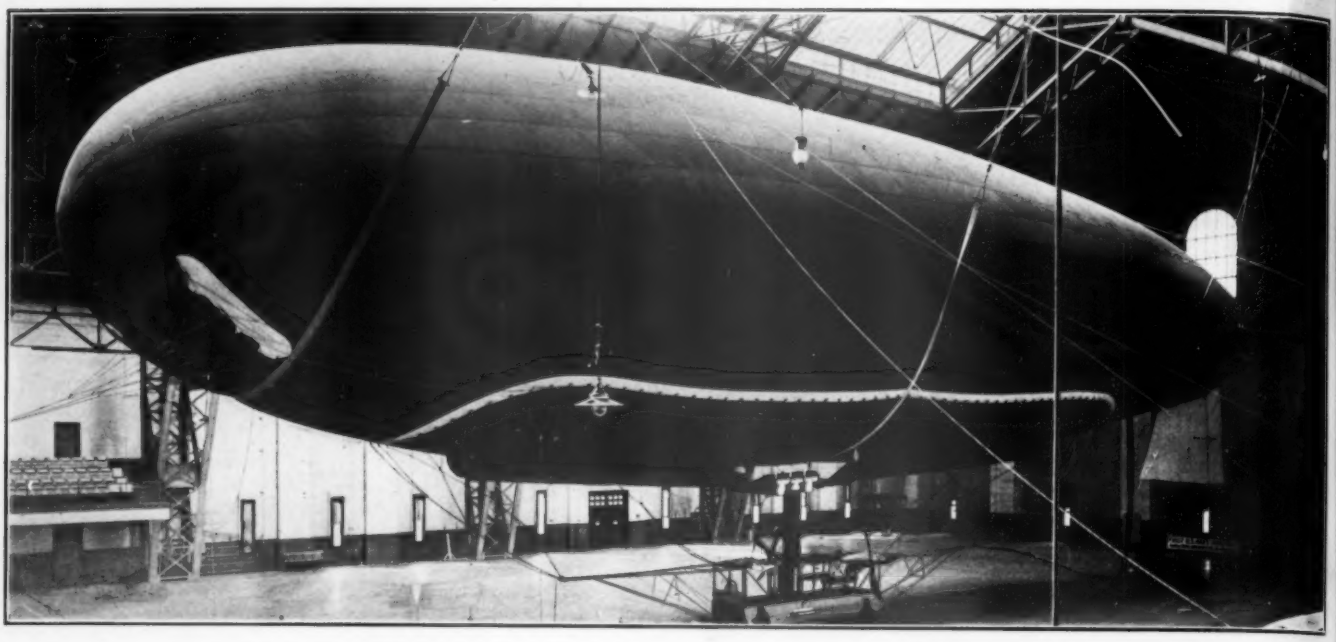
Forging of stem before removal of flash. Note the excess of metal used.

FIG. 3. RESULTS OF SOME TESTS.

Physics Notes

DISCONTINUOUS FLUID MOTION PAST A CURVED BOUNDARY. H. Levy. (*Proc. Roy. Soc.*, 92, pp. 285-304.) The author investigates the following problems: The two dimensional motion of a curved surface through a fluid of negligible viscosity; the form of the free stream line and the calculation of resistance components. Gravity is neglected and it is assumed that the moving surface gives rise to a free stream line along which the pressure and velocity are constant. Solutions are obtained by a series of conformal transformations.

EFFECT OF HEATING ON THE ELASTICITY OF ALUMINUM. H. L. Dodge. (*Phys. Rev.* 6, pp. 312-318.) Results of tests made upon samples of hard and soft aluminum wire showed that aluminum behaves much the same as other metals, except that the temperature coefficient of elasticity for hard aluminum wire is almost constant. By annealing, the temperature coefficient is increased for low temperatures and decreased for higher temperatures, the separating temperature being around 100 degrees C. The following conclusions are made concerning the effect of temperature on Young's modulus for metals: If the metal be thoroughly annealed, the modulus becomes a function of the temperature; with increase of temperature the modulus decreases, while the rate of change increases; if the metal be heated by the passage of an electric current the change in the modulus is a temperature effect only.



The New Navy Dirigible, DN-1

By Charles F. Smyth

The Navy dirigible DN-1, built by the Connecticut Aircraft Company at New Haven, Conn., was shipped recently to the Naval Aeronautical Station, Pensacola, Fla., for the final flying tests, the preliminary power plant and blower tests having been previously passed by the government inspector at the factory.

The dirigible DN-1 is of the non-rigid type, i.e., one in which the gas bag maintains its shape by the pressure of the contained gas and the gondola is carried entirely by a suspension fastened to the bag itself. Its overall dimensions are: length 175 feet, height 50 feet, and beam 35 feet. The balloon carries a volume of 115,000 cubic feet of hydrogen gas, which gives a total lift, less space used by the ballonets, of approximately 7,000 pounds, based on the lift of its hydrogen gas at .068 pounds per cubic foot.

There are two ballonets for navigating purposes, one in the rear, with a volume of 8,000 cubic feet, and one forward, with a volume of 7,000 cubic feet. These ballonets serve both to navigate the airship and to assist in maintaining its shape, which at different altitudes is apt to be largely affected by temperature changes, causing expansion and contraction.

The gondola, or car, of the dirigible is fastened to the bag by means of a suspension composed of numerous ropes and cables, fastened in turn to the belly bands of the bag. This suspension is capable of great lifting strength and is made so as to afford the greatest efficiency combined with the least possible strain on any portion of the bag's surface, allowing for an even distribution of weight on all parts of the belly band.

In the car itself are the various units of machinery necessary to operate the dirigible. These are composed of:

First—The power plant, which is an eight-cylinder Sturtevant 140-horse-power engine at 2100 revolutions per minute.

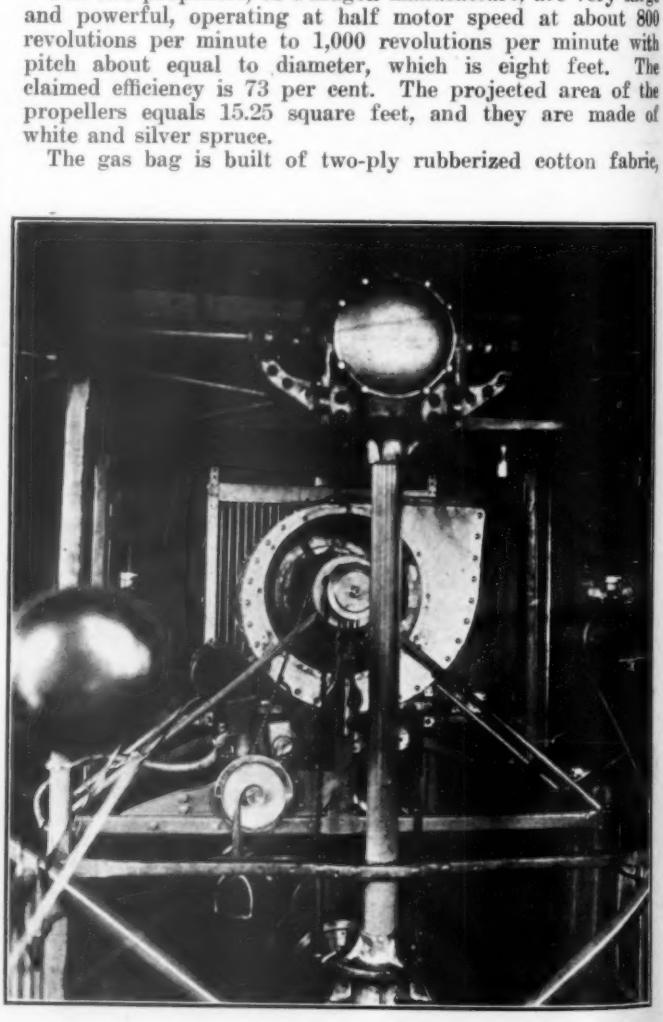
Second—The transmission, composed of the lower gear case, through which the power is delivered by means of an upright shaft into the two cross shafts arranged overhead that drive the two four-bladed propellers.

Third—The blower is located directly over the engine and is driven by a belt off the main shaft drive. The blower is used to keep the ballonets inflated and is operated by signal from the pilot to engineer, who in turn shifts the T-piece levers that open and close the big air valves leading from the blower into the two metal cross tubes called the T-piece.

As a safety device, an auxiliary motor is installed to drive the blower in the event of main power plant stalling. This auxiliary, which is a 1½-horse-power air-cooled single-cylinder Indian motor, is mounted on the side of the blower frame and is connected to the blower by a chain which operates in a two-way clutch, permitting the operator to engage or disengage either means of power plant for blower drive at will.

The two propellers, of Paragon manufacture, are very large and powerful, operating at half motor speed at about 800 revolutions per minute to 1,000 revolutions per minute with pitch about equal to diameter, which is eight feet. The claimed efficiency is 73 per cent. The projected area of the propellers equals 15.25 square feet, and they are made of white and silver spruce.

The gas bag is built of two-ply rubberized cotton fabric,



VIEW OF THE TRANSMISSION ON THE DN-1, SHOWING INDIAN AUXILIARY ENGINE

whose strength is 70 pounds per inch for both warp and weft, and whose permeability is 35 cubic feet in 24 hours at two feet water pressure. All seams are extra wide, with double rows of stitching. The cloth is diagonally doubled, outside ply being bias, and yellow in color to prevent the deterioration from light. The gray inside ply is waterproof. The ballonets are made of a two-ply cotton fabric with rubber coating between plys; strength, 40 pounds for warp and weft.

This dirigible is designed to attain speed between 25 and 30 miles per hour, with endurance at full speed of two hours. It has a passenger carrying capacity for seven men. The rate of ascent and descent is 6 feet per second.

It is equipped with a full set of instruments, including barometer, barograph, pressure gages (envelope, ballonets, gasoline and water), chronometer, air speed meter, inclinometer, statoscope, compass, all made of light and compact materials. There is also a signaling system of different colored lights from pilot to engineer post.

The suspension proper of the dirigible is of standard European design, the ropes being carried through pulley blocks on the car, and are attached to belly band by means of splicing and looping brought out at each eyelet.

A complete first aid kit is provided, as well as provision for supplies and food for long trips.

Scientific Research Needed for Solution of Aeronautic Problems*

By Lieutenant-Colonel George O. Squier, U. S. A.

The following are some present problems connected with the developments of military aviation and aerostation:

I. AERODYNAMICS.

(*a*) Continue the development of the mathematical theory to explain the aerodynamic phenomena recorded in the aerodynamical laboratories, and to forecast further results.

(*b*) Obtain solutions for the speed and direction of flow of air about geometric and aerotechnic forms, and develop experimental means to visualize or map the speed and direction of flow.

(*c*) Map the currents of the upper atmosphere which may be of most use in aerial navigation, and evolve simple practical rules for the guidance of pilots.

(*d*) Give fuller explanation of the phenomena of soaring, *i.e.*, airplaning indefinitely without motive power.

(*e*) Develop equations and laws of comparison by which the behavior of large aircraft may be more accurately foretold from tests of models. Apply further the principle of dynamical similarity.

(*f*) Investigate more direct and effective methods of securing a lift or thrust in the air from the consumption of fuel.

(*g*) Complete theory of the air-screw.

II. ENGINE PROBLEMS REQUIRING RESEARCH.

(*a*) *Fuel.* Possibly the most far-reaching problem is fuel. A fuel that will carry more power into an engine per unit volume will be a direct gain. Attempts have been made to combine alcohol, gasoline, acetylene, pieric acid, ether and other hydrocarbons with the above object in view. Questionable results have followed. There has been an increase of power, but nothing so far commercially or practically useful. This question must be studied with the greatest of care and from a truly research standpoint.

(*b*) *Solid Fuel.* Solid fuels that can be converted into liquid in small quantities just prior to use, are desirable for military aviation. In case of accident from shot or shock, leakage of liquid fuel is a danger. Solid fuel could be carried in quantity with less danger.

(*c*) *Engine Cooling.* The problem of radiation is important. If some substance could be found that would circulate through the cooling system, at higher temperatures than water, it is probable that greater engine efficiencies would result. Oils, salt waters, and other materials have been tried with indifferent success.

(*d*) *Liquid Fuel Pipes.* Tubing that will resist vibration (causing rupture) is desired. An oil and gasoline proof rubber tubing is reported as used in Europe. This development is highly important, not only for tubing, but for containers in which to carry liquid fuel. Some sort of fabric and rubber tank that would really resist the action of gasoline, would be of the highest benefit. A difficulty lies in the fact that the tanks are large, say 20 to 100 gallons' capacity. The structural problems would be serious. The tanks now used are large and of metal. Vibration causes much difficulty and leakage.

(*e*) *Metal Coating.* The protecting of the metal parts of an airplane, especially the fittings and cables, is a serious problem. A material is desired that will really prevent dangerous corrosion. Nickel plating over copper is very good, but will not suffice. Rust strikes through very rapidly. Baked enamel is the best coating. It is impossible to apply in many cases.

(*f*) *Sound.* The question of eliminating the noises involved in the operation of aircraft is one of importance. The peculiar note of the propeller of a Zeppelin can be heard from several miles, and is usually the first warning of its approach at night.

III. MISCELLANEOUS.

(*a*) *Physiological.* Study the Physiological and psychological effects of low density air at high altitudes on the performance of pilots.

(*b*) *Transparent Wing Covering for Airplanes.* A wing covering which would answer the following general requirements would be of great value to military aviation:

Weight not more than five ounces per square yard.

It should present reasonably great resistance to flame.

It should be reasonably proof against action of salt water, moist air, extreme dryness, and quick temperature changes.

It should not stretch in any direction. Its ability to retain original form as placed on the airplane is very important.

It should have tensile strength of at least 75 pounds per inch width in any direction.

Its tendency to tear and split because of tack holes through it, or because of bullet holes, should be as small as possible.

(*c*) *Development of Light Alloys for Airplane Construction.* With pure aluminum alloys, it is believed that a great deal can be done in this direction. So far no alloy has been developed, except possibly in Germany, which can compare with average Alaskan spruce in its "specific tenacity."

(*d*) *The Structure of Gusts.* It is believed that this is of sufficient importance to aviation to warrant considerable expense in its study. Painstaking investigation of the character of eddy formations caused when wind strikes trees, hollows, cliffs, etc., and the character of disturbances created by canyons, swamps, deserts, etc., would be of great value to aviators. This can be done not only by smoke and toy balloon work in the vicinity of obstructions such as the above, but also by photographic work in wind channels. A set of simple rules laying down just what the aviator may expect on one side or another of canyons, cities, trees, lakes and swamps would be very helpful in aviation.

(*e*) *Radio-Apparatus for Aircraft.* The subject of radio-intercommunication between aircraft in flight, and between aircraft and the earth requires for its solution the highest possible efficiency and reliability combined with minimum weight. A present tendency is to entirely separate the power plant from the main engine of an aircraft. The generator body in this case has a streamline figure and a separate small air-screw is provided. Among other methods the oscillion is being tried as the actual source of continuous electromagnetic waves.

(*f*) *Bullet Proof Gasoline Tanks.* Development of a material with which to line or construct tanks to contain the gasoline in an airplane in which a bullet hole will quickly

* Abstract from an address of Lieutenant-Colonel George O. Squier, U. S. A., before the National Academy of Sciences, Boston, Mass., November 14, 1916.

close, entirely or partly at least. This would enable many a flier to get back to his own lines after having been fired upon.

(*g*) *Development of a Fabric as Good as, or better Than, Irish Linen, for the Covering of Airplanes.* There has not been manufactured in this country a fabric suitable for use in covering airplanes. The fabric should answer all requirements laid down under Transparent Wing Covering, and be, in addition, such as to shrink the proper amount without harm when cellulose solution is applied. It is possible that long fiber cotton might be developed that would answer the purpose. We must become independent in all lines affecting our military aviation. Today we depend entirely upon Ireland and England for our linen, and the supply is becoming very low in this country.

(*h*) *Aviators' Clothing.* Much is still to be done in devising non-inflammable and protective clothing for aviators. This question is intimately connected with personal armor and safety in case of fall.

(*i*) *Ground-Speed Indicator.* An instrument which would measure the actual speed of an aircraft over the ground would be useful in the operation of military machines.

IV. PHYSICS OF THE AIR

(*a*) *High Frequency.* At present we have no evidence of vibrations in the air much greater than 40,000 to 60,000 cycles per second, but there is no reason to deny the possibility, nor indeed the probability, of vibrations of 100,000 to 200,000 or even a million cycles per second in the ordinary air we breathe. If these vibrations exist, and it is a wonder if they do not, may not they have an important function to perform in nature? The reason, of course, we do not perceive them is because they are above the upper limit of the human ear, and also do not directly affect any of our other senses. Electromagnetic waves of these frequencies existed, though all the time unperceived, until Hertz devised a "detector." At present the detector for high-frequency air vibrations is the manometric flame, and it would be of great importance to invent a detector for air vibrations which would indicate their presence or absence up to 500,000 or 1,000,000 per second. If we had such a "detector" and also means for producing such vibrations in air, it would be possible to provide a system of intercommunication, over short distance at least, based upon ultra-audible sound waves. We could, for instance, devise a noiseless foghorn as an aid to navigation.

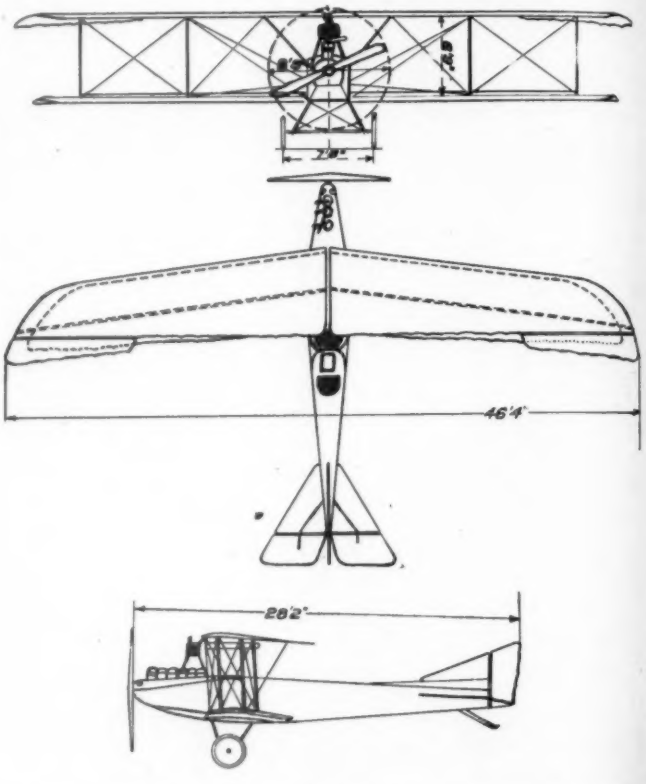
(*b*) *Elasticity.* The elasticity of the air has been made to serve in a great variety of machines to perform useful work. The original dynamite gun of Zalinski utilized the elasticity of compressed air as the explosive for propelling the projectile. The best condensers for radio-telegraphy employ air as the dielectric. Any break-down automatically repairs itself and thus adds greatly to reliability. The passenger automobile itself has been made possible by the development of the pneumatic tire.

(*c*) *Friction.* The magnitude of the friction of the air against the surface of bodies moving through it may absorb large amounts of energy. The average velocity of shooting stars is 25 miles per second. They vary from 10 to 30 miles a second. The earth's orbital velocity is about 19 miles a second. It is sometimes added and sometimes subtracted from the shooting star's velocity according to the way the body enters the atmosphere. The friction of the air at these velocities is so great as to volatilize metals. A mass of one gram of air moving with this velocity, 25 miles per second, has a kinetic energy of 8.0937×10^{12} ergs, which is sufficient to lift one ton of matter, 2,000 pounds, to a height of 298 feet above the earth's surface. One gram is a small piece of matter to possess this potentiality. This enables us to comprehend, in part at any rate, the disastrous results of the cyclone, where houses and forests are bodily cut down as by a giant steel knife.

(*d*) *Mass.* A cubic foot of air at 0 degrees C. and 76 cms. pressure weighs .08071 pounds, according to Rayleigh. A room $18 \times 20 \times 10$ feet contains 3,600 cubic feet. The air in it, therefore, weighs 290.556 pounds. In liquid or solid form this air could be removed from the room with difficulty by a strong man. On this view, it appears that we have been passing our lives on the bottom of a deep ocean of comparatively heavy fluid, and that only recently have we learned how to utilize the dynamic reaction of this fluid to construct machines for transportation freely in three dimensions in the interior of this ocean. Who among us is wise enough to foretell what these machines may yet accomplish?

The Austrian D.F.W. Biplane

Jean Lagorgette, in a recent issue of L'Aerophile, gives an interesting description of a machine that was captured by the Italian forces at Asiago last April. Although it was attached to the Austrian army and went under the name of Lohner, it is unquestionably a D.F.W., either of German construction or built from the German designs. This biplane shows a departure from the type which gave the D.F.W. the nickname of the "banana," and which was illustrated in the August 1 issue of AVIATION.



The trailing edge of the upper wing is now straight, the leading edge being sloped back, so that the chord steadily decreases toward the tip. The lower wing, however, has a typical swept-back form. The upper wing is braced to the fuselage by a pair of struts sloping obliquely outward, instead of relying solely on a tetrahedral cabane, as was formerly the custom.

The elevator flaps and rudder are of nearly quadrilateral shape in this new machine, whereas in the 1914 type they were shaped in an irregular curve, and the ailerons are warped, as is the case on so many other Teutonic airplanes. The motor employed is a Wurkslowseki, or Austrian make, and is of the 6-cylinder vertical type. The above and other details of the design are shown by the drawings reproduced herewith.

Aeronautical Patents

Copies of these patents may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."

ISSUED NOVEMBER 7, 1916.

1,202,610. Filed Jan. 16, 1914. To Benjamin Thaw, Jr., Pittsburgh, Pa. A sleeve valve gasoline engine.

1,204,989. Filed April 13, 1916. To Anthony Janowski, Hazleton, Pa. Airplane with overhead stabilizing propeller

ISSUED NOVEMBER 21, 1916.

1,205,676. Filed May 4, 1916. To Horace Leonard Short, A. E. Short and H. O. Short, Battersea Park, England. A folding wing airplane.

Construction of Kite Balloons

By R. H. Upson

Types of military apparatus which are considered necessities today may be on the scrap heap tomorrow; and yet by a curious reversal of conditions the obsolete, the forgotten, often comes back to play again its part in a new generation. There have been many illustrations of this during the present war. Hand grenades are revived from the 18th century, trench mortars from the 100 Years' War, and hand to hand fighting from the ancient Greeks and Romans.

The kite balloon, now in general use in the European armies, is merely a combination of two principles, one nearly as old

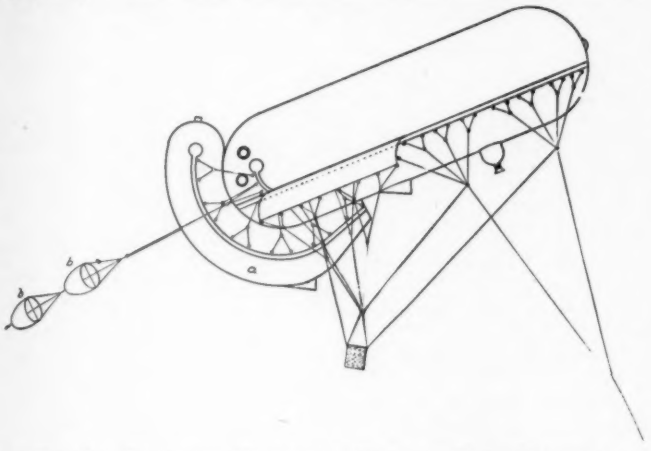


FIG. 1. STANDARD EUROPEAN TYPE OF KITE BALLOON

as civilization itself, the other discovered over a century ago. Neither principle alone ever quite filled the bill. A man-lifting kite required a strong wind to fly it. An ordinary captive balloon on the other hand could only be flown in a comparative calm. But in the kite balloon we have a combination that can take care of either condition.

The apparatus is essentially an elongated balloon which is always kept in an inclined position like a kite. Thus the wind tends to lift it by blowing against the under side. This counteracts the contrary tendency of a wind to blow the balloon over toward the ground. Kite balloons are now recognized as essen-

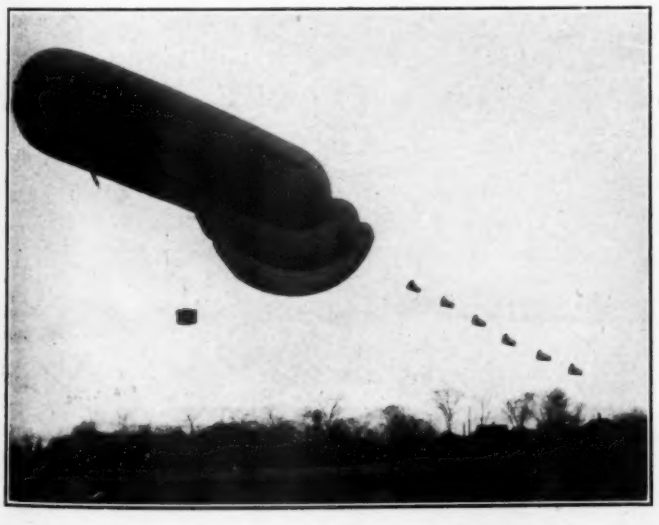


FIG. 2. THE ORIGINAL GOODYEAR MODEL

tial in nearly all modern warfare on land and sea. They are superior to the old fashioned captive balloons; and even the airplane is ill suited to perform the kite balloon's particular function of range finding and general observation of the line.

Notwithstanding its great superiority over the spherical balloon, the kite balloon still left something to be desired in the matter of steadiness. Even when loaded with tail cups, the use of binoculars was difficult, and severe sea-sickness was an item to contend with. The highest wind in which good observation could be made was about 27 miles per hour. The resistance was also rather high. This carried the balloon over to a considerable angle, seriously limited the altitude attainable, and at the same time put a disproportionate strain on the cable.

Fig. 1 shows the standard European type of kite balloon. Its steadiness depends on the combined action of the "steering bag," *a*, and the "tail cups," *b-b*. Its resistance may be considered as made up of several parts:

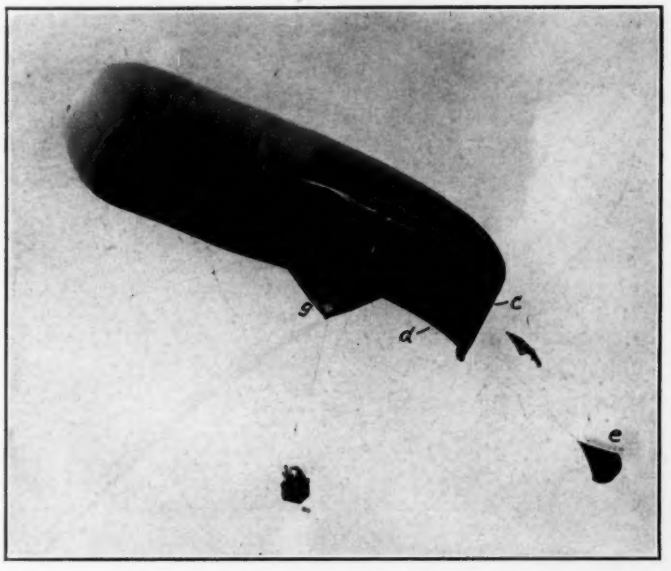


FIG. 3. THE GOODYEAR KITE BALLOON (CAPACITY 25,000 CUBIC FEET)

1. The resistance of the gas-bag itself, a function of its size and shape.
2. The resistance of the steering bag, greatly augmented by the large opening at its front.
3. The pull of the tail cups, determined by the number of them necessary to maintain a reasonable steadiness.

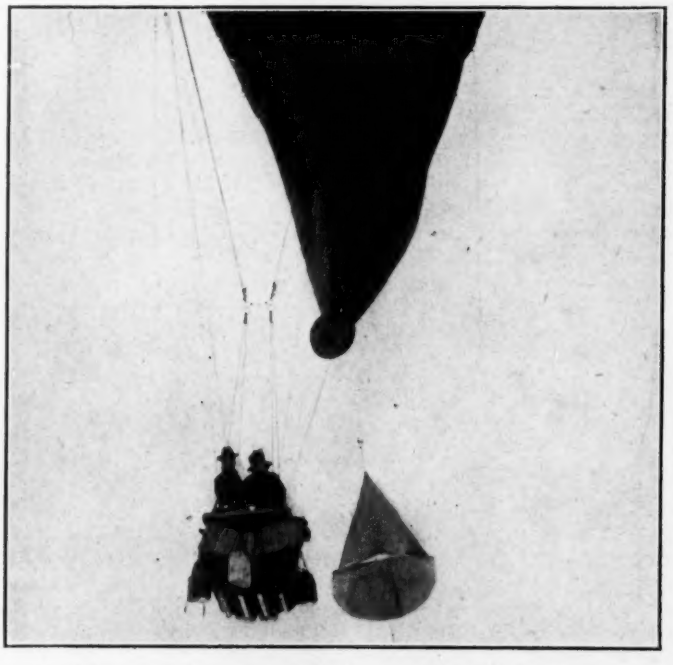


FIG. 4. KEEL OF THE GOODYEAR KITE BALLOON

4. The resistance of the cordage and basket.
5. The resistance of the anchorage cable.

Fig. 2 shows the original model, made by the Goodyear Tire & Rubber Co., which was probably the first produced in this country. Here a modest attempt was made to increase the steadiness by increasing the effective lateral surface of the

steering bag. It was also found possible by proper design to cut down considerably the amount of cordage previously used, thus effecting a slight increase in resistance.

Experience with this type of balloon however, showed that a radical departure in design was necessary if any marked improvement over the existing forms was to be achieved. A basic study was made of each different part. Numerous experiments, failures and successes pointed the way, and finally the results were combined and reduced to practical form in

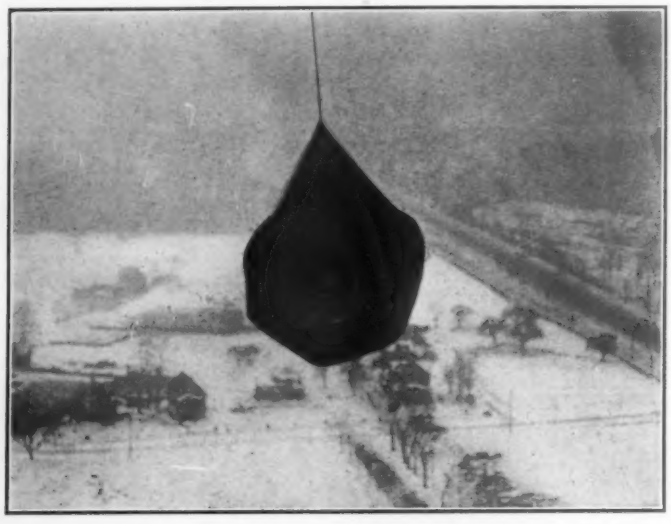


FIG. 5. FORM OF TAIL CUPS USED WITH THE GOODYEAR KITE BALLOON

what is known as the Goodyear Kite Balloon. Its principal outstanding features may be seen in Fig. 3.

1. The shape of the gas-bag is so modified as to have a minimum resistance consistent with other requirements.

2. The steering bag is replaced by an air funnel, *c*, which is the only inflated protuberance on the balloon. This carries the keel, *d*, the tail cup, *e*, and has a valve at its lower end through which air enters to make good any deficiency in pressure. With this construction a comparatively small hole will supply all the air necessary to keep the balloon well inflated under all conditions.

3. The keel, like the funnel, is non-rigid, being supported entirely by a proper balance of forces. Its great advantage over the old steering bag is the fact that it presents a double concave surface to the wind so that it is held in the wind by a positive pressure on both sides at once. In this way any tendency to yaw is stopped almost before it starts. On the other hand, the old type of steering bag will allow considerable deflection or swing of the balloon before its corrective influence is felt. In addition to this the keel has only a small fraction of the resistance of the steering-bag, is lighter in weight and is simpler in practical use. It will keep practically the form shown in Fig. 4, in any wind from a calm to 45 miles per hour.

4. The side fins indicated by *g* in Fig. 3, are so shaped and disposed that they help in the stability as well as in the kite effect of the balloon.

5. The function of the tail cups, *e*, has been reduced almost wholly to one of dampening the motion of the balloon in a gusty wind. Contrary to expectations it was found that the form of construction of the tail cup was a considerable factor in its stability. Its present form which was adopted as a result of practical and wind tunnel experiments on numerous different designs is illustrated in Fig. 5.

6. The resistance was further cut down by making the balloon more nearly self contained and eliminating superfluous cordage and protuberances.

7. In other balloons it was found that the gas leakage through the valve and various appendices was commonly many times greater than all other sources of leakage combined. The valve was therefore designed especially to prevent leakage. Its size is more than ample for all requirements of captive or free balloon use. The air valves have also been made tighter and more efficient, thereby cutting down the quantity of air required to keep the balloon properly inflated.

8. For maximum efficiency the inclination of the balloon to the air must be calculated with considerable exactness. If it is inclined too much it carries the balloon over and puts an undue strain on the cable. On the other hand if the balloon is too nearly horizontal the lift of the wind is lost. There is a certain best inclination for each balloon at which it is perfectly steady, the pull on the cable is near a minimum and the altitude a maximum. In order to preserve this proper angle for different conditions of use, the basket is made adjustable so that it can be moved forward or back when necessary. In a thirty mile wind, there should be no motion apparent in the basket, the cable tension at the balloon should be less than 1,000 pounds, and an altitude of 4,000 feet readily attainable.

Landing at Night

One of the greatest problems that confronts the pilot of an aeroplane while making a night flight is that of landing without mishap. Recognizing the value of night flying, the Germans practised it assiduously previous to the war, and devised a very ingenious scheme for assisting pilots to land in aerodromes in safety in the dark.

A large white light is placed in the centre of the aerodrome, sunk in a pit in the ground, and covered with glass plate of sufficient thickness to withstand the shock, should the wheels of the flying machine pass over it. At a distance of about 250 feet from this light, and also sunk in the ground, are four red lights corresponding to the cardinal points of the compass. Each of the red lights is connected by subterranean cables to a wind vane, mounted on a mast or tower at some convenient point.

At night the central light burns continually, while the number of red lights showing is determined by the direction of the wind. If the wind is east, then the centre white lamp and the red light in the east will be showing. Should the direction of the wind be northeast, then both the north and the east lanterns will be showing. The electrical connections from the wind vane ensure this.

The device cannot, however, correctly tell the aviator the height he is above the ground. This has to be very nicely gauged if a machine is to be brought down in safety.

A system for constantly altering the lights was also gotten up so that an aviator has to understand the secret code before he can discover his whereabouts. This, of course, prevents the lights at the various aerodromes being used by enemy aircraft.

One great danger with the system is that these lights reveal the position of an aerodrome; it is possible, however, that means have been found for overcoming this difficulty by obscuring the lights until an aeroplane overhead signals by code —either by lights or by firing a pistol—that he is a friend, when the lamps below are immediately switched on for his guidance.

Photo by Paul Thompson

This illustration, which has been reproduced from a French official photograph taken in the Somme district, shows one of the many mobile guns being used against German aviators.

Course in Aerodynamics and Airplane Design*

By Alexander Klemin, A.C.G.I., B.Sc., S.M.

Instructor in Aeronautics, Massachusetts Institute of Technology, Member of the Aeronautical Society of Great Britain and Ireland

and

T. H. Huff, S.B.

Instructor in Aeronautics, Massachusetts Institute of Technology,

Copyright, 1916, by A. Klemin. All Rights Reserved.

PART 1—SECTION 9

Triplane Combinations—Uses of Negative Tail Surfaces

In the November 1 number of AVIATION, the reader will find a complete treatment of the aerodynamic properties of the triplane, with a complete record of the experimental results obtained at the Massachusetts Institute of Technology. It remains for us only to summarize the main results, and to review recent constructional applications of the triplane principle.

The main conclusions from these experiments are:

(I.) At the stalling angles such as 16 degrees the triplane and biplane give nearly the same maximum lift; the triplane has a materially lower resistance at this angle, giving a much better performance at slow speed. Thus the L/D ratio at 16 degrees is 4.5 for the monoplane, 5.6 for the biplane, and 6.5 for the triplane.

(II.) At angles below 12 degrees the drag coefficient is not greatly different in the three cases, but the lift for the triplane is considerably reduced; it is inferior to that of the biplane which again is inferior to that of the monoplane.

(III.) The best L/D for the triplane combination is only 12.8 as compared with 13.8 for the biplane, and 17 for the monoplane.

(IV.) The center of pressure motion is almost identical with that of the biplane. We have seen previously that the center of pressure motion for the biplane is nearly that of the monoplane. This demonstrates that the commonly made assumption of monoplane center of pressure motion for a wing of a biplane also holds for the triplane. This is an important fact in view of the methods employed in stress diagrams.

The experimental results for K_y and L/D for the triplane as compared with the monoplane and biplane are summarized in Table 1:

TABLE 1

TABLE SUMMARIZING COMPARATIVE VALUES OF K_y AND L/D FOR MONOPLANE, BIPLANE AND TRIPLANE.

	Monoplane.		Biplane.		Triplane.	
i	Actual K_y	Percentage.	Actual K_y	Percent. of Monoplane.	Actual K_y	Percent. of Monoplane.
0.....	.000486	100	.000432	88.8	.000404	83.0
2.....	.00103	100	.000864	83.8	.000776	75.4
4.....	.00145	100	.00123	85.4	.00109	75.7
8.....	.00218	100	.00186	85.2	.00169	77.4
12.....	.00278	100	.00244	87.6	.00226	81.2
16.....	.00277	100	.00273	98.5	.00267	96.4
	L/D	L/D	L/D	L/D	L/D	L/D
0.....	8.6	100	6.3	73.2	6.1	70.8
2.....	16.3	100	12.2	74.7	11.4	69.8
4.....	16.8	100	13.8	82.0	12.8	76.1
8.....	13.8	100	11.3	81.9	11.1	80.4
12.....	10.0	100	9.5	95.0	8.9	89.0
16.....	4.5	100	9.6	124.0	6.5	145.0

Interference in Triplanes

Dr. Hunsaker's paper also deals fully with interference in triplanes. It is important in the structural design of the wing girder to know what portion of the lift and drag to attribute to each wing. The comparitive efficiency of each wing is also important from the point of view of overhang. It appears from Table 2 that the upper wing is very much the most effective of the three and the middle wing the least effective. The very poor lift of the middle wing is caused by the interference with the free flow of air due to the presence of the uppr and lower wings.

One interesting point brought out by Dr. Hunsaker toward the end of his paper was the fact that when the effects of the upper and lower wings were combined, results identical with that of a simple biplane combination were obtained. This would tend to show that the interference in the case of a triplane is similar to interference in the case of a biplane. The upper wing of a triplane would seem to be influenced by the middle wing in the same way that the upper wing of a biplane is influenced by the lower wing of a biplane. Again the lower wing of a triplane would seem to be influenced by the middle wing in the same way that the lower wing of a biplane is influenced by the upper wing. These are important considerations to be kept in mind when modifications of the triplane are attempted such as stagger, overhang, décalage, etc.

TABLE 2

TABLE OF VALUES FOR LIFT AND L/D FOR EACH WING OF A TRIPLANE COMBINATION AS RATIOS TO LIFT AND L/D OF MIDDLE WING.

Angle of Incidence.	Lift Upper.	Lift Middle.	Lift Lower.	L/D Upper.	L/D Middle.	L/D Lower.
0.....	2.68	1.0	1.82	3.63	1.0	2.30
2.....	2.14	1.0	1.76	3.18	1.0	2.13
4.....	1.91	1.0	1.64	2.59	1.0	1.69
8.....	1.56	1.0	1.36	1.49	1.0	1.37
12.....	1.56	1.0	1.31	1.30	1.0	1.34
16.....	1.49	1.0	1.20	1.22	1.0	1.17

Some Considerations for Triplanes

There are two types of airplanes, of quite dissimilar types for which triplanes have been employed in this country, the huge Curtiss flying boats, and the recent Curtiss speed scout. It is interesting to consider what the possible advantages of the triplane are at these two extremes of design.

In the heavy types, particularly in seaplanes, the increased size must be developed without increase in landing speed. To insure about the same landing speed, the loading must remain at a figure of about 5 pounds per square foot. And for an aeroplane of four times the ordinary weight the wing area must be increased in like proportion. Monoplane construction is obviously impractical for such great areas of wings, and even with the biplane there is an enormous wing span. Such a span introduces great difficulties from the stress point of view and from the point of view of housing and handling. The employment of a triplane enables the span to be kept within reasonable dimensions and also permits the employment of larger aspect ratios.

At high angles the lift of a triplane is only 1.1 per cent less than that of a biplane of the same area. At 16 degrees the L/D ratio of a triplane is 16 per cent better than that of a biplane. At stalling attitudes, the triplane has therefore very decided advantages, giving a greater reserve power at low speeds in alighting. At 4 degrees incidence for best L/D the triplane does not show up so well, and requires an increase in power of about 6 per cent. It would seem as if the 6 per cent increase in power can be compensated for by the possibility of a less heavy type of construction with decreased span. Also there is the possibility of employing much greater aspect ratios than in biplane work, and this may compensate to some extent for the losses due to extra interference.

Triplanes for Fast Speed Scouts

From the recent photographs issued by the Curtiss Company, it seems clear that the original machine (see AVATION August 15) was transformed (see AVIATION October 15) by placing the triplane wing structure on the same body structure as for the biplane. With approximately the same wing area divided between these planes the aspect ratio was increased very considerably, without exaggerating the span, giving some aerodynamical advantage. The extremely narrow blade like wing permitted the single plane bracing system to be used with much greater security. The employment of a single plane bracing system cuts down resistance very considerably, and if this bracing system is only possible with

* This Course commenced in the August 1, 1916 issue of AVIATION AND AERONAUTICAL ENGINEERING, will be completed in 24 issues. It will embody the fundamental aeronautical data necessary for airplane design, and present the design of standard machines in complete, simple and systematic form.

triplane narrow blade construction, then triplane construction would be a very sound tendency in the design of small fast machines.

USE OF NEGATIVE TAIL SURFACES

In Section 6 of the course we saw the possibility of using a negative tail surface so as to give static longitudinal stability, and in the problem which follows a definite case will be taken as an illustration of this possibility. In other methods of attaining stability such as employment of the reversed curvature wing or of stagger-décalage combinations, dynamic stability might not follow the static stability unless tail surfaces were employed. In such cases the tail surfaces would probably have to be placed at zero angle to the wings, or even at a small positive angle. It is for this reason that

FIG. 1. DIAGRAM FROM EIFFEL TO SHOW DEVIATION OF STREAM-LINES BY "DOWN-WASH" OF WINGS.

the stable biplane arrangements, apparently so advantageous are not more frequently used in practice.

Effect of Influence of the Wash of the Wings on Stabilizer Surface

Eiffel in his later experiments conducted some tests on tandem wings. One important result of these tests was to prove that an aeroplane built with tandem wings would be aerodynamically disadvantageous. Another result was that the down wash of the front wing would change the flow relative to the rear wing so that the angle of incidence of the latter would be smaller than that of the former. The allowances made for the change in the angle of incidence were arrived at indirectly by measuring lift and drag on the second wing while in the presence of the first, and are not entirely reliable. Fig. 1 represents Eiffel's conclusions diagrammatically for a specific case.

The relative wind for the front wing is horizontal; the chord of the front wing is at 10 degrees to the horizontal, the chord of the rear wing is at 4 degrees to the horizontal, with a décalage of 6 degrees. Owing to the downwash of the front wing the stream lines at the rear wing now make a negative angle of 7 degrees with the horizontal, and the rear wing is actually at a negative angle of 3 degrees to the stream.

Owing to the fact that the tail surface of a machine are so much further away from the wings, the deviation will be less perceptible and the following practical formula gives satisfactory results:

If i = angle of incidence of the wings,

Deviation of stream = $(\frac{1}{2}\ i + 1)$

To take a concrete case, if the wings are at 8 degrees incidence, and the stabilizer is placed at a negative angle of 2 degrees to the chord, then its incidence will be

$$(8 - 2) - (\tfrac{1}{2}\ i + 1) = 1$$
$$(8 - 2) - (8/2 + 1) = 1$$

This deviation has an important bearing in the design of stabilizing surfaces on the angle of setting between the chord of the wing and the line of the stabilizing plane.

Problem on the Design of Tail Surfaces to Give Longitudinal Static Stability

The requirements of static longitudinal stability may be briefly stated as follows:

(1) The machine must be in stable equilibrium at some angle of incidence, generally the angle of normal flight, say 6 degrees for purposes of illustration.

(2) If the angle of incidence of the aeroplane is from any cause less than 6 degrees, there should be a positive restoring moment or stalling moment; if for any reason, greater than 6 degrees, there should be a negative or diving moment.

(3) Within a few degrees of the position of equilibrium the righting moments should be comparatively small so as to give flexibility of control.

(4) As the displacement from the position of equilibrium increases the righting moments should increase also.

(5) The righting moments should never be excessive and should never exceed ⅓ of the possible moment which can be exercised by the elevator.

These results can be readily obtained by the use of a suitable negative tail. We shall now take a concrete case of an unstable orthogonal biplane with a total wing area of 432 square feet; wing section R. A. F. 6; the center of gravity of the machine, as shown in Fig. 2. The loading is such that the machine has an angle of incidence of about 4 degrees at a speed of 70 miles per hour. The gap chord ratio is 1.0. The tail surfaces, stabilizer and elevator are taken together, are placed at a distance of 16 feet from the center of gravity. It is required to design a stabilizer to meet the above requirements.

We will assume that:

(a) The design of the stabilizing surface is carried out prior to wind tunnel tests.

(b) The center of pressure motion for each wing of the combination is precisely similar to that of the wing acting alone, so that L and D forces on each wing may be taken as acting at precisely the same point they would on a monoplane wing; this assumption is justified by results of both the biplane and triplane experiments.

(c) The resultant force on the tail surfaces may be taken as approximately perpendicular to the moment arm and as being equivalent to the lift. This is not far from true for angles within normal flight and simplifies our calculations enormously. The stabilizer surface is taken as being equivalent to a flat plate.

(d) The displacement of the vertical through the center of gravity for varying angles of incidence is neglected.

The machine selected for this problem is shown in Fig. 2 with the position of the center of gravity as indicated. It has a wing area of 432 square feet. The normal angle of flight being 4 degrees, it must weigh from elementary considerations (introducing .85 as correcting factor for K_y due to biplane effect),

$$W = K_y A V^2 = .0014 \times .85 \times 432 \times 70 = 2580 \text{ pounds}$$

Taking moments about the center of gravity the general equation for the pitching moment at any angle is

$$M = 2La - Db + Db' - 16\ R \qquad (1)$$

Where a is the distance between the vertical center of gravity line and the parallel line of lift on each wing (the wings assumed to carry equal loads), b and b' are the distances from the horizontal axis through the center of gravity to the point of application of the drag forces. The distance of 16 feet is assumed as the distance from the center of gravity to the point of application of the resultant force R acting on the stabilizer as defined previously.

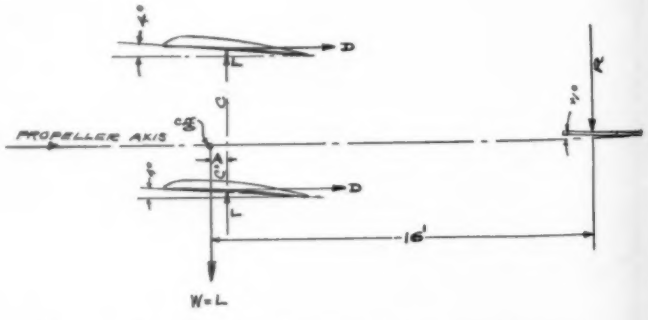


FIG. 2. DIAGRAM ILLUSTRATING STABILIZER PROBLEM.

Since the Fig. 2 the distance $b' = 4$ feet; $b = 2$ feet; the quantity $(b—b') = 2$ and the equation can be simplified to the following form:

$$2\ (La — D—8\ R) = M \qquad (2)$$

The lift arm a varies of course with the center of pressure motion.

Unfortunately no set method of design exists for this particular problem. Area of stabilizer and the angle of setting to the wing chord have to be assumed more or less arbitrarily until the right combination is found, although each designer will probably find a short cut method. In two instances after a number of tentative combinations, the following values were found to specify our conditions fairly well.

Stabilizer, aspect ratio 3, area 50 square feet, angle of setting to wing chord 2 degrees. The K_y coefficients for the stabilizer treated as a flat plate can be taken from the curves given in Section 4 of the Course.

TABLE 3.
TABLE ILLUSTRATING COMPUTATIONS IN STABILIZER DESIGN

Angle of wings to wind degrees	K_y corrected for biplane effect	K_x	Velocity of machine $= V$ (m.p.h.)	Resistance of wings in lbs. $D = K_x 432\ V^2$	Lift on machine in pounds $= L$	Arm for drag in feet $= b - b' = 2$ ft.	Arm for lift in feet	Moment due to drag in lbs. ft.	Moment due to lift in lbs. ft.	Total moment for wings in lbs. ft.	Resultant angle of tail plane	K_y coefficient for flat plate aspect ratio 3	Arm for stabilizer in ft.	Lift on stabilizer in lbs.	Moment due to stabilizer in lbs. ft.	Resultant moment about c.g. in lbs. ft.
0	.000493	.000075	110.	392	2560	2	−1.2	+784	−3020	−2236	−3	−.00051	16	−309	+4950	2614
2	.000882	.000072	82.5	212	2560	2	− .6	+424	−1500	−1076	−2	−.00035	16	−119	+1910	834
4	.00121	.000093	70.	197	2560	2	− .30	+394	− 750	− 356	−1	−.00018	16	−44.1	+ 704	348
6	.00155	.000130	62.	216	2560	2	− .24	+432	− 600	− 168	0	0	16	0	0	− 168
8	.00187	.000166	56.6	230	2560	2	− .12	+460	− 300	+ 160	1	+.00018	16	+28.7	− 459	− 299
12	.00242	.000255	49.8	275	2560	2	0	+550	0	+ 550	3	+.00051	16	+65	−1040	− 490

Stabilizer set at −3 degrees to wing chord. Area of stabilizer = 50 sq. ft., Area of wings = 432 sq. ft.
+ moments tending to stall machine. − moments tending to dive machine.

A careful distinction has to be made between the apparent angle of incidence of the stabilizer to the relative wind and the real angle, taking account of the deviation of the stream in accordance with the formula given. Thus if the wings are at an incidence of 6 degrees to the wind, and the stabilizer is at 2 degrees to the wing chord, the real angle of incidence becomes

$$(6—2) — (\tfrac{1}{2}.6 + 1) = 0 \text{ degrees}$$

The computations for the setting finally selected are shown in the Table 3. The curves of moments due to the wings, the moments due to the stabilizer, and the resultant moment are shown in Fig. 3. The conventional method of regarding moments tending to stall the machine as positive, and moments tending to dive the machine as negative is adhered to.

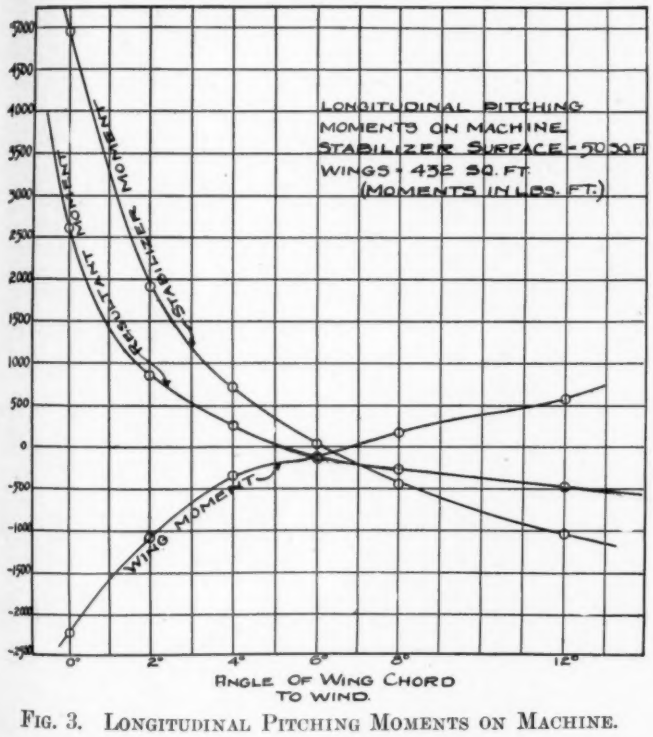

LONGITUDINAL PITCHING MOMENTS ON MACHINE
STABILIZER SURFACE - 50 SQ. FT.
WINGS - 432 SQ. FT.
(MOMENTS IN LBS. FT.)
STABILIZER MOMENT
RESULTANT MOMENT
WING MOMENT
ANGLE OF WING CHORD TO WIND.

FIG. 3. LONGITUDINAL PITCHING MOMENTS ON MACHINE.

It is seen from the curves of Fig. 3 that the solution is only fairly good. Equilibrium is secured at 6 degrees. Approximately on either side of the equilibrium position, the correct moments are obtained. If the machine goes below 6 degrees the resultant moment tends to stall it back to 6 degrees. If the machine goes above 6 degrees the resultant moment tends to dive it back to 6 degrees; that is satisfactory so far. But the resultant moment curve is far too steep about the position of equilibrium and the machine is sometimes too stable to be under perfect control. The problem is left in this form, however, because an improvement of the solution would be an excellent exercise for a student. The variations possible are in

I Length of stabilizer arm.
II Area of stabilizer.
III Angle of setting of stabilizer.

It must also be pointed out that the approximations employed, and the factors neglected, such as the effect of the body and other structural parts, are so numerous that in constructing an actual machine a wind tunnel test would be finally necessary.

Reference for Section 9

The Aerodynamical Properties of the Triplane, by J. C. Hunsaker and T. H. Huff. *Engineering*, July 21, 1916. Reprinted in AVIATION AND AERONAUTICAL ENGINEERING, November 1, 1916.

Book Reviews

THE DESIGN OF AEROPLANES

By A. W. Judge

(Whittaker & Co. $3.50. 212 pp.)

This volume is designed particularly to fill the needs of draughtsmen and other students who have had little mathematical training and wish to secure a working acquaintance with the purely practical side of the subject in the least possible time. It is rather in the nature of a designer's handbook, as the author's efforts have been directed rather to the collection and tabulation of the best existing data than to the production of a really original piece of work.

The attempt has been made to smooth the path of the reader by giving formulae, which will reduce the solution of problems to a mere matter of substituting in equations, thus materially reducing the computation required on a new design. Directions are given for the application of model tests to full-sized machines, correcting for aspect ratio, stagger, decalage, etc., and for the variations with changing values of VD.

The writer treats the construction of performance curves, and gives an explanation of the stresses in wing assemblies. There are several appendices giving tables of weights and strength of materials, etc., and a chapter devoted to a review of applied mechanics, including the various formulae for strength of materials under different conditions of loading.

AVIATION

An Introduction to the Elements of Flight

By Algernon E. Berriman

(George H. Doran Company. Price $4.00. Pp. 359)

Mr. Berriman is an engineer of great reputation and a practical writer, and he has stated the most difficult problems of aviation in this introduction to the elements of flight in the most simple manner, combined with scientific accuracy.

In discussing equilibrium, longitudinal and lateral stability, steering, considerations of resistance, the advantages of cambered surfaces and of uneven distribution of pressure, all the unusual pitfalls of popular books have been avoided.

The historical record is chronological and very complete, beginning with Sir George Caley's early experiments, and carrying the reader right up to the work of the Wrights and to the first cross channel flights. One chapter is devoted to accidents, and another to hydroaeroplanes. There is a good bibliography and valuable appendices on the Wright Patent litigation, the petrol engines, high-tension magneto, pressure and resistance constants, analysis of forces on wing sections, the travel of the center of pressure on wing sections, etc. Constructional details are treated rather briefly.

News of the Fortnight

Miss Law Made Records in Chicago-New York Flight

Miss Ruth Bancroft Law flying an old model Curtiss pusher airplane flew from Chicago to New York on November 19 and 20. Her flight was one of the most remarkable feats that has ever been performed in a heavier than air machine. While her elapsed time is slower than that made by Victor Carlstrom two weeks earlier when he covered 967 miles in 8 hours, 28 minutes, 30 seconds actual flying time as against 884 miles covered by Miss Law in 8 hours, 55 minutes, 35 seconds, the fact that Miss Law had never had any previous cross country experience marks her trip as an extraordinary performance.

Her machine is of a two-years' old type. The driver's seat far from being protected from the wind by a modern type body is practically unprotected, increasing the physical strain of the flight incalculably. In this machine, which appears a flimsy contraption compared to the Model R-4 Curtiss which Carlstrom used, Miss Law flew 590 miles without stopping. This is the longest non-stop flight ever made in the United States.

Her total elapsed time from Chicago to New York exceeded Carlstrom's by but 27 minutes and 5 seconds. As against 205 gallons of gasoline in Carlstrom's giant machine, Miss Law could carry but 53 gallons. With those 53 gallons of gasoline Miss Law covered 590 miles at a stretch. Making due allowance for the powerful following wind this performance is nothing short of a revelation.

RECORD OF MISS LAW'S FLIGHT FROM CHICAGO TO NEW YORK

Left Chicago, (Eastern time)	8:25:00	A. M.
Arrived Hornell, N. Y.	2:10:00	P. M.
Left Hornell	3:24:00	P. M.
Arrived Binghamton, N. Y.	4:20:00	P. M.
Left Binghampton	7:23:00	A. M.
Arrived New York	9:37:35	A. M.
	Time.	Miles.
Chicago to Hornell	5:45:00	590
Hornell to Binghamton	0:56:00	90
*Binghamton to New York	2:14:35	204
Total	8:55:35	884

*This figure is based on Miss Law's speedometer. The Aero Club figures that she flew 210 miles.

The Navy Wants Seaplane Speed Scout

A letter recently sent to all constructors by the Bureau of Construction and Repair, of the Navy Department, outlines the requirements for a high-speed naval seaplane. It is understood that the Navy is anxious to purchase a great many such craft if a satisfactory one can be developed. The letter follows:

SUBJECT: SMALL HIGH SPEED NAVAL AIRPLANE

Gentlemen:

It is desired to obtain without delay naval airplanes approaching the following description:

Speed range 50 to 95 miles per hour with full load consisting of one man (160 pounds), 2½ hours' fuel and oil, a radio set, weight 50 pounds, and usual instruments, consisting of tachometer, air speed indicator, altimeter and inclinometer. The radio set will be supplied by the Government, and in the design its weight may be assumed located at the center of gravity. The span shall not exceed 28 feet. A structural factor of safety of 6 shall be provided.

The climb, seaworthiness and other features not mentioned are to be the best consistent with the requirements above. It is suggested that designers study the problem contemplating biplane or triplane wing arrangements, and a single central float of stream line form and light construction. The float will be expected to operate satisfactorily in smooth water. The float may be stuffed with kapok to retain buoyancy if smashed in rough water. It is suggested that a lighter float construction than is usual can be provided if the pontoon struts be fitted with springs of rubber or steel. This airplane is intended to be launched from the catapult and should have bracing to withstand an acceleration in starting of 32 feet per second, the impulse being applied to the stop.

If any manufacturer will develop a satisfactory type, it is expected that a large number will be ordered. In the meantime manufacturers are requested to submit designs and if any are prepared to guarantee performance, consideration will be given to the placing of orders at once for experimental machines.

Respectfully,
D. W. TAYLOR.
Chief Constructor, U. S. N.,
Chief of Bureau.

Squadron Flight from Mineola to Princeton

Under command of Captain Raynal C. Bolling, 1st Aero Company, N. G. N. Y., eight airplanes flew, in battle formation from Mineola, L. I., to Princeton, N. J., on Saturday, November 18, and returned on Monday, November 20.

The flight, made in military manner throughout, is a great tribute to the work accomplished since the $13,281,666 appropriated by Congress for aeronautics became available last August, and stands as a definite mark of achievement by the regular Army instructors who have had charge of the work with the 1st Aero Company, N. G. N. Y., since last August. Captain Raynal C. Bolling was in charge of the flight. As it was largely through his personal efforts that the 1st Aero Company was formed, the flight is an achievement for which he, perhaps, deserves more credit than anyone else.

The aviators were: Captain R. C. Bolling, N. G. N. Y., commanding officer, Captain Ralph Taylor, N. G. Va., Lieutenant A. B. Thaw, N. G. N. Y., and the following sergeants of the 1st Aero Company, N. G. N. Y., W. P. Willetts, J. H. Stevenson, R. B. Noyes, and H. S. Salmon. Captain Joseph E. Carberry and Captain W. G. Kilner accompanied two of the National Guardsman as passengers.

Cord Meyer, "Hobey" Baker, Philip A. Carroll and H. B. Blakely also flew down from New York to Princeton on November 18 and back on November 21. All of the latter have been taking private flying lessons during the past summer except Blakely, who is a professional aviator.

All the aviators used Curtiss JN-4 machines except Blakely, who flew an L.W.F. At one time on the return journey Blakely, who was carrying a passenger, attained an altitude of 11,400 feet.

Cessna Airplane Factory is Located at Wichita

The Clyde B. Cessna airplane factory is located in a building on the grounds of the Jones Motor Car Company, according to the Wichita (Kan.) *Beacon*, which says:

"Wichita has the only airplane factory and school in the middle West."

Building H of the Jones Motor Car Company of Wichita's factory will be used by Cessna, and material is arriving daily for equipping the building. Two monoplanes will be placed on exhibition at the factory. It is the plan of the Cessna Company to build three machines this winter, one of them providing for a passenger. Should additional capital be available, it may be possible to build at least six biplanes and monoplanes.

Fly from San Diego to Los Angeles

Floyd Smith, chief pilot of the Wright-Martin Aircraft Corporation, accompanied by Instructor Burns of the same concern, made a successful air trip from San Diego to Los Angeles recently.

They used a Martin 125-horse-power reconnaissance machine of the latest type and flew at an altitude of 6,000 feet. Their course lay over the ocean's edge, dodging at Oceanside a heavy bank of fog. They left San Diego at 1.20 p.m. and arrived at the Inglewood aviation field at 3.07. The machine is one of the type the company is making for the United States Government.

Movement for Aero Company in Kentucky

B. A. Osborne of Lexington, Ky., has returned to his home on furlough from Mineola, where he has been stationed most of the summer, and is attempting to get permissioin of the adjutant general to establish a National Guard Aero Company in Kentucky. "It will be necessary," he said recently, "for the state to buy the first machine. The government then will provide four other machines, four reserve engines and four trucks. The first cost for the establishment of a corps is approximately $7,500 to the state."

There Is No Difference Between Them

In response to an inquiry addressed to the National Advisory Committee for Aeronautics as to the proper terms for designating male and female operators of heavier-than-aircraft, the Committee has decided that the term "aviator" is a proper term to use in either case. Such terms as "birdman," "bird-woman," "aviatrix," etc., appear undesirable and unnecessary.

Bids for Army Hydroaeroplanes

On November 23 the bids for the twin-motored hydroaeroplanes for the Aviation Section, Signal Corps, U. S. A., were made public. The specifications for these machines were published in AVIATION AND AERONAUTICAL ENGINEERING of November 1.

The bids ranged from $13,300 to $29,497, for machines with motors. The high speeds varied from 65 to 90 miles per hour, and the climb from 2500 to 6500 feet in ten minutes. The low speed was specified at 45 miles per hour, and the machine must rise from the water in 1000 feet. The specifications asked for bids on 4, 8, 12, 16, 32, 64, 80, 90, 112, 126, and 148 complete machines. An unofficial report of the bids follows:

The Gallaudet Company: 1 in 120 days; climb, 5090 feet; speed, 85 miles per hour.

Four at $28,111 each; 32 at $25,920 each.

The Wright-Martin Aircraft Corporation (1): 1 in 150 days; 1 every 2 days thereafter.

Twelve at $29,497; 148 at $25,800 each.

The Cohen Motors Company: 2 in 85 days; 1 every 45 days thereafter; climb, 2500 feet; speed, 75 miles per hour.

Four at $25,700 each; 80 at $23,150 each.

Benoist Aeroplane Company: 1 in 70 days; 1 every 7 days thereafter; climb, 3200 feet; speed, 65 miles per hour.

Four at $14,800 each; 90 at $13,300 each.

New York Aero Corporation: 1 in 90 days; 1 every 14 days thereafter, climb, 2600 feet; speed, 75 miles per hour.

Four at $24,000 each; 148 at $20,000 each.

Buffalo Aero Corporation: 2 in 90 days; 1 every 15 days thereafter; climb, 6500 feet; speed, 90 miles per hour.

Four at $18,475 each; 80 at $14,520.

The Wright-Martin Aircraft Corporation (2): 1 in 150 days; 1 every 2 days thereafter.

Twelve at $26,275; 32 at $24,656.

The Aeromarine Engineering and Sales Company: 1 in 100 days; climb, 3000 feet; speed, 75 miles per hour.

Four at $19,000 each; 16 at $18,000 each.

The Heinrich Company: 1 in 70 days; 1 every 16 days thereafter; climb, 4000 feet; speed, 85 miles per hour.

Four at $14,850 each; 16 at $12,875 each.

The Standard Aero Company: 1 in 65 days; 3 every 7 days thereafter; climb, 3500 feet; speed, 80 miles per hour.

Four at $22,500 each; 148 at $20,000 each.

Curtiss Aeroplane and Motor Corporation: Climb, 2000 feet; speed, 65 miles per hour.

Four, or as many as desired, at $22,500 each.

Burgess Company: Climb, 3000 feet; speed, 75 miles per hour.

Four without motors at $12,000 each; 32 at $11,000 each.

L. W. F. Engineering Company: 2 in 120 days; one every 7 days thereafter; climb, 4000 feet; speed, 75 miles per hour.

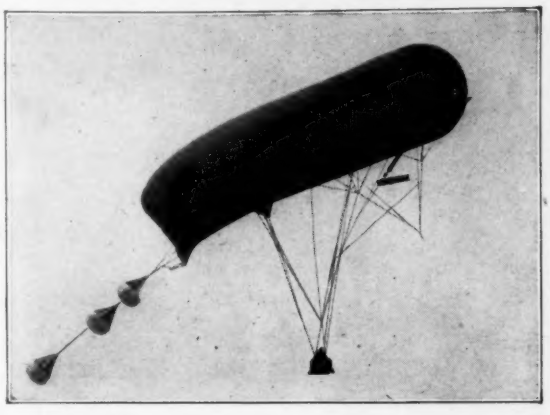
Eight at $22,500 each; 32 at $19,000 each.

Curtiss Has Nearly $7,000,000 of Foreign Orders

The New York *Commercial and Financial Chronicle* recently stated that its understanding is that at the present time the Curtiss Aeroplane and Motor Company of Buffalo has between $6,000,000 and $7,000,000 of foreign orders and is going ahead filling them.

"The foreign contracts, says the *Chronicle*, have been readjusted and are now in satisfactory shape. Approximately 25 per cent. or 30 per cent. of the large foreign orders had been completed when a delay occurred at the request of the foreign Government, due to the fact that the advance in the art of aviation has progressed so fast that the specifications laid down when the order was given had been outdistanced. The remainder of the foreign order has now been finally specified and the company is again going ahead actively in the manufacture of planes and motors. The foreign Governments have reimbursed the company for inventories, overhead expenses while the suspension existed, and have made a satisfactory adjustment of profits. The delay therefore meant only that the completion of this contract would go over until 1917.

"The company now has orders for between $6,000,000 and $7,000,000 worth of airplanes which will be completed by the latter part of 1917. The new foreign specifications generally call for larger planes and more powerful engines, generally of the seaplane type for coast defense purposes, with 200 horsepower motors."



Lighter-Than-Air Equipment

Advances for the nation and for the industry are constantly being made by The Goodyear Tire & Rubber Company in solving the complex problems of materials and construction for balloons of *any* size and *every* type.

A new Goodyear kite balloon has recently been developed which operates under practically any weather conditions, and will not pitch, roll or yaw even in a stiff gale.

New tests and many exacting flights to demonstrate durability, have been made with the Goodyear balloon which won first place in the last International Gordon Bennett Cup Race and is now on display in the Goodyear Museum.

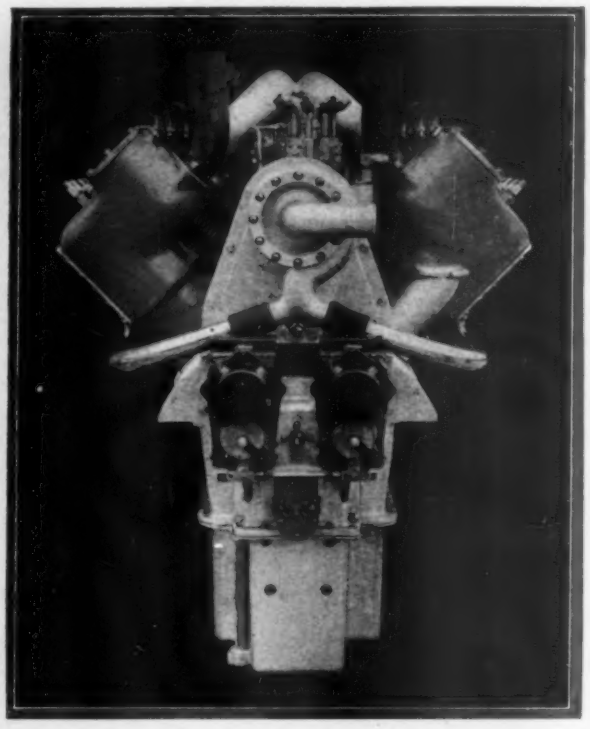
For several years the Government has largely depended upon the free, spherical and kite balloons manufactured by Goodyear.

Manufacturing experience, technical men, and factory equipment place Goodyear in a position to meet any balloon requirements.

We will gladly send you on request samples of balloon fabric, complete specifications, and prices.

The Goodyear Tire & Rubber Company
Akron, Ohio

GOODYEAR
AKRON



Four More Advantages

of the **geared type** of aviation motor, which is becoming **more and more recognized** as the **ultimate type,** are well shown in the

THOMAS

135 H. P. Aeromotor

5. Ease of installation.

6. Short overall length.

7. Separate propeller shaft relieves crankshaft of severe gyroscopic stresses.

8. Maximum power without sacrifice of propeller efficiency.

Contractors to U. S. Army and Navy.

Thomas Aeromotor Co., Inc.
ITHACA, N. Y.

Thomas

Harvard Undergraduate Aero Training Fund

The report of the Harvard Undergraduate Aero Training Fund just issued shows a record of achievement which should be very encouraging to the five hundred odd subscribers.

Of the seventeen men who were sent to the Curtiss, Wright and Thomas schools, twelve have qualified for their pilot's license, four have not yet completed their course of four hundred minutes in the air, and the seventeenth was unable to attempt his flight to qualify for the license before the opening of college because of the weather conditions. Speaking of the success of the ten men who attended the Curtiss school and each of whom qualified for his license, the report says:

Due to favorable weather conditions, to the untiring efforts of Lieutenant Rader, to the conscientious earnestness of the Harvard men, and to the adequate equipment of the Curtiss plant, every man before the end of the summer successfully passed his license test without an accident. That this was a success that the most optimistic could not have predicted will be readily realized by those who are familiar with the difficulties, delays and accidents surrounding aviation schools here or abroad.

In conclusion the report reads:

The men who completed their courses are now desirous of additional training to qualify them as expert military aviators. Recent legislation at Washington has provided for an aerial reserve. Whether or not the War Department will take advantage of this legislation in such a manner as to make it practical for these Harvard men to become members of this reserve is still a matter of conjecture.

The need of trained military aviators is just as apparent now as it was last spring. The committee is convinced of the importance and value of the work accomplished, yet it is not yet prepared to say that the work should be carried on in the same manner another year. Letters have been received from time to time from other universities intimating that this work started by Harvard men will by its example be indirectly responsible for more widespread results than were actually accomplished.

The committee is now endeavoring to get co-operation from the Government. Whether or not in the opinion of the committee the work should be continued another year depends largely on the attitude of the Government in regard to the further training of the men who have already qualified as pilots.

The committee wishes to express its appreciation of the interest extended by the sponsors, of the generous financial support of the Aero Club of America, graduates and others, and of the assistance and valuable advice given by those interested in the movement. Also the committee especially appreciates the co-operation of the schools and instructors, and above all else—the earnest, unfailing energy, patience and determination of those undergraduates who devoted their summer to this work, and who are primarily responsible for the results obtained.

ROGER AMORY, '10, *Chairman,*
ALLAN FORBES, '97,
GORDON H. BALCH, '12.

The financial statement follows:

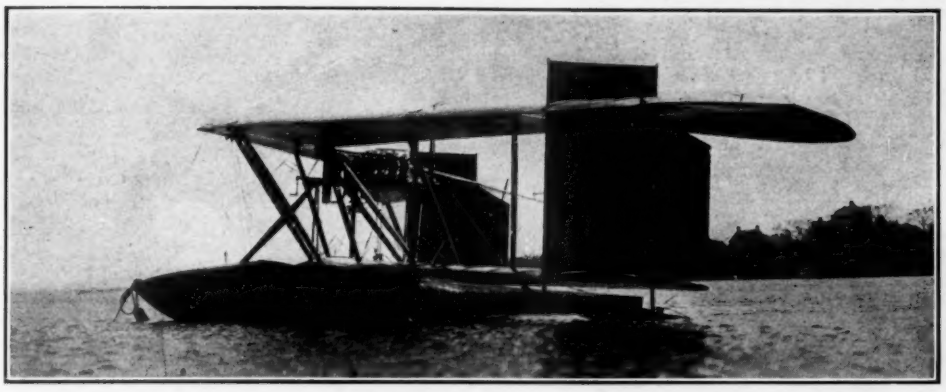
Contributions	$9,028.08
Aero Club of America and Robert Bacon	500.00
Undergraduate deposits	900.00
Interest and bank balance	12.08
Total	$10,440.14
Tuition and equipment	$7,835.41
Administration	845.74
Refund of deposits	600.00
Exchange charges	1.50
Cash balance	1,157.49
Total	$10,440.14

Permanent Force of 20,000 British Aeros Asked

Lord Montagu of Beaulieu, speaking recently at Edinburgh, Scotland, on aircraft policy, said that when peace came the British air service must be the last to be reduced. A naval invasion might not come, but by means of one hundred airships it might come on a scale infinitely larger, which it would need all the British aircraft forces to repel. Of 2000 miles of coastline, at least 1000 would have to be defended by aircraft. If in the country a permanent force of 20,000 aeroplanes existed, the cost would not be more than $75,000,000.

He also said that England had reached the position when the Air Board should be given control at least of the supply side, and there should be one united air service for the country. He looked forward to an imperial air service. England should not only be strong and well armed, but the air service must take front rank in protecting the empire.

BURGESS FLYING BOAT



After conclusive tests the Burgess Company offers a water and air craft ideal for sportsmen.

Safety and comfort never before attained in flying is realized in this latest model, built under the patents of Burgess, Curtiss and Dunne.

The crew is seated in a steady, seaworthy hull, provided with wind and spray shields, deep cushions, lockers, and all the appointments of a modern high-speed launch.

Absolute inherent balance is assured by the Dunne system, a balance as certain and simple as that afforded by the keel of a sailing yacht.

Steering is centered in a single wheel with duplicate control for pilot and passenger.

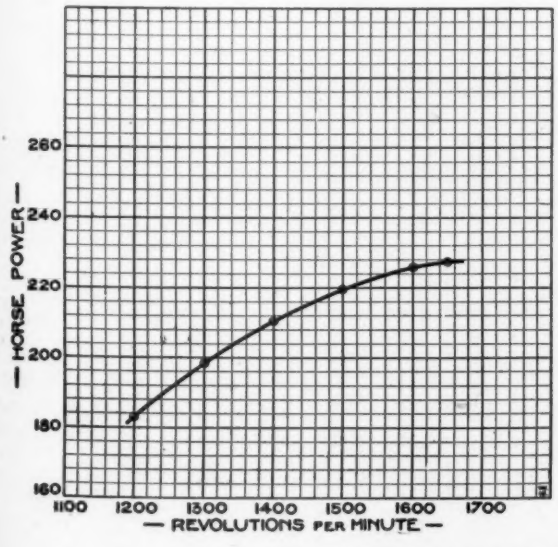
The engine may be started without leaving the cockpit.

The construction is worked out with a nicety of detail which must be seen to be appreciated.

THE BURGESS COMPANY, Marblehead, Mass.

NOTICE

Owing to changes and improvements our 5″ x 7″ eight-cylinder motor, formerly known as Model "VX" rated at 160 horsepower, will hereafter be known as Model "VX-3" and will be rated at 200 horsepower. The following is a record of electric dynamometer test of stock motor "VX-3" No. 3512 as delivered from the Production Department.



Duration of test (minutes)	60
Average R.P.M.	1403.33
Average load on scales (lbs.)	449.64
Average horsepower	**210.26**
Maximum observed horsepower	210.50
Minimum observed horsepower	208.10
Total Gas. consumption (lbs.)	111.30
Total Gas. consumption (U. S. gals.)	18.10
Gas. consumption per hour (lbs.)	111.30
Gas. consumption per hour (U. S. gals.)	18.10
Gas. consumption (lbs. per H. P. hour)	**.528**
Total Oil consumption (lbs.)	6.50
Total oil consumption (U. S. gals.)	.844
Oil consumption (U. S. gals. per hour)	**.844**
Oil pressure—start of test (lbs.)	71.00
Oil pressure—end of test (lbs.)	72.00
Oil pressure—maximum test (lbs.)	74.00
Oil pressure—minimum test (lbs.)	68.00
Average inlet water Temp. (F.)	116.90
Average outlet water Temp. (F.)	140.50

CURTISS AEROPLANE & MOTOR CORPORATION

Buffalo, N. Y.

DU PONT

The Standard Dope
for
Aeroplane Surfaces

DuPont Dope is used on over 90% of the machines built in this country for U. S. and foreign governments.

DuPont Dope deposits a tough, flexible, and waterproof film that imparts great strength to the fabric, with correct shrinkage.

DU PONT CHEMICAL WORKS
E. I du Pont de Nemours & Co., Owner
120 Broadway New York

DILLNER-MEYER MFG. CO., INC.
SUCCESSOR TO A. J. MEYER CO.

Airplane Turnbuckles and Fittings of Uniformity, Toughness and High Resistance to Crystalization

SCREW MACHINE PRODUCTS OF EVERY DESCRIPTION

819-821 John Street
WEST HOBOKEN, N. J.

G. A. Cavanagh's Book on Models

George A. Cavanagh, author of "Model Aeroplanes and Their Motors," recently issued by Moffat, Yard & Company, was born in New York City April 15, 1894. After graduating from grammar school he became interested in the study of aviation and, like many other successful men in the aeronautical field, took to the construction and flying of model aeroplanes as a practical means of acquainting himself with the elementary principles of flight. During the year 1912 he broke the world's record for Controlability of Flight of models. In 1914 he held the world's distance record for models rising from the ground, and also the duration record for models rising from the surface of the water.

Aside from being a writer on model aeronautics, Mr. Cavanagh also lectured on the subject. In the interests of the Aero Science Club of America and the Y. M. C. A. model organizations, he has delivered lectures before many student bodies, whose members have been familiarized with the subject through his efforts.

Captain James V. Martin's automatic lateral stabilizer installed on one of the U. S. Government's Curtiss training machines at Mineola, L. I. The machine under the guidance of Pilot-Aviator Adams made the flight from Mineola to Princeton with locked ailerons.

Perfect Starter Tests

The following tests of the Perfect airplane engine self-starter have been supplied by the manufacturer to AVIATION AND AERONAUTICAL ENGINEERING.

The starter is of the four-cylinder cranking type, made by The Motor-Compressor Company, Newark, N. J., and acts alternatively as an air compressor, discharging into a storage tank, and a starting engine receiving its supply of air from the storage tank. The starter was coupled directly to the crankshaft of the eight-cylinder 5 x 7 inch VX motor No. 3080 on one of the test stands, with storage tanks, control valves, gauges, etc., attached to the frame of the stand.

DEMONSTRATION TEST.
Friday, April 21, 1916.
Time 1:30 to 6:30 P.M.
No. of starts, 75.
ENDURANCE TEST.
Saturday, April 22, 1916.
Time 9:20 A.M.

Engine was started by starter tank pressure from the previous day, being 210 pounds. Engine was stopped and started 47 times, replenishing air supply 4 times, after which time a detailed record was kept of pumping frequencies and starting frequencies, as follows:

Time at start.	Pressure in tank at start and remaining from previous operation.	Starts and stops.	Pressure remaining in tank.	Time at finish.
10:47	200	12	91	10:50½
11:03	204	12	104	11:06
11:16	210	14	98	11:19½
11:32¼	200	12	101	11:35
11:45	230	17	110	11:48
1:15¾	220	15	101	1:18¾
1:27	225	19	100	1:30¼
1:39½	219	14	105	1:43
2:02½	230	8	155	2:03½
2:45	155	1	145	2:48
3:00½	230	16	110	3:04
3:11	229	14	104	3:13¾

230 ran down to 100 pounds and then pumped up again in 26 seconds; engine revolutions 1000 revolutions per minute.

NOTE: The time in the first column deducted from the time in the last column equals the length of time it required to start and stop the engine and make the number of starts recorded, also includes the time for pumping in the above recorded tank pressure; as in the instance of 11:45 to 11:48 three minutes elapsed and seventeen stops and starts were made and operating as a pump, replenishing the pressure to 220 pounds.

The starter was dismantled on Monday morning, April 24, after the test was run, in the presence of several engineers, and was found to be in good condition in every respect.

A New Packard Airplane Engine

The Packard Motor Car Company is experimenting with a new airplane engine. The new engine will be of the 12-cylinder variety, built at an included angle of 40 degrees, instead of 60 degrees, in order to reduce head resistance.

The crankshaft will be of the three-bearing variety, 2¾ inches in diameter. The cylinders will have overhead valves which will be operated by an improved overhead camshaft construction which the company has perfected during the past year. The cylinders will be made out of solid steel billets with applied steel jackets. The engine will be designed so that electric lighting and starting can be supplied when desired.

Reduction gears will be provided so that propeller can be run anywhere from 900 to 1400 revolutions per minute when the engine is turning over 2100 revolutions per minute, at which speed it is expected to develop more than its rated horse-power. The engine will weigh approximately 800 pounds and will develop approximately 250 horse-power.

Radium Compound No. 6

is specified in United States Government
"Aeronautical Specification No. 1002." For

Illuminating

Barometers Clocks Compasses
Speed Indicators Inclinometers, etc.

WE ALSO MAKE OTHER GRADES OF RADIUM COMPOUND

Send us an instrument for specimen treatment

Radium Chemical Company

Forbes and Meyran Aves. **Pittsburgh, Pa.**

CHRISTOFFERSON MOTOR CORPORATION

Aeronautic Motors

CHRISTOFFERSON AIRCRAFT MFG. CO.

Military and Sporting
Land and Water Aeroplanes

NEW YORK
61 Broadway

School and Factory
REDWOOD CITY, CAL.

SAN FRANCISCO
57 Post Street

WITTEMANN-LEWIS AIRCRAFT COMPANY INC.

Aircraft Manufacturers

Standard and Special Designs

Ocean Terrace and Little Clove Road **STATEN ISLAND NEW YORK CITY**

Tel. West Brighton 1629

FOXBORO
TRADE MARK

AIR SPEED INDICATOR

Forewarns and Prevents Stalling

Accurately indicates the relative wind pressure, the force that holds the plane in the air.

Light and compact.

Send for Bulletin No. BI-110.

THE FOXBORO CO., Inc.
FOXBORO, MASS., U. S. A.
New York Chicago San Francisco

A Standard Dope of Proven Quality

NAIAD AERO VARNISH

WATERPROOF—AIRTIGHT

Prevents Changing in Cloth Tension with the Atmosphere

Send 25c for sample can to:

AVIATION DEPT.
THE C. E. CONOVER CO.
101 Franklin St. **New York City**

IT IS REPORTED THAT—

Two new instructors were added recently to the staff which is being recruited to handle the work of instructing applicants in the new government aviation school at Ashburn, Ill. The latest addition to the force, which already included a number of flyers of note, are VICTOR VERNON and A. E. JOHNSON, the former a graduate of the Curtiss school.

A military balloon landed near Washington Court House, Va., recently, after a trip from Akron, Ohio, a distance of about 120 miles. The balloon was piloted by C. H. ROTH and C. A. WOLLEN, of Akron, and made the trip in 3 hours and 45 minutes. Reports state that the balloon was of the dirigible type, shaped like a large cigar, but carried no motive power. It was steered by means of planes and the trip was made for the purpose of testing the steering, elevating and lowering planes to demonstrate their availability for practical purposes.

SERGEANT WILLIAM OCHER, who left the aviation field at Mineola Thursday afternoon, November 16, on the first leg of his flight to Washington, landed in Philadelphia after a trip of seventy-five minutes. The distance was 100 miles, giving him an average of eighty miles an hour. The purpose of the journey was to demonstrate the stabilizer, invented by A. J. Macy of Chicago. A company headed by John W. Wilson, cousin of the President, is backing the stabilizer.

J. WALTER WOOD STRUTHERS, of New York, who, while flying with Charles Deere Wiman, of Moline, Ill., fell 900 feet to earth at Governor's Island on September 8, died on November 13 at the post hospital on Governor's Island as a result of the accident.

GENERAL P. TOZZI has been placed in command of the Italian Royal Flying Corps mission to the United States of America. Until he received orders to return to Italy, recently, MAJOR R. PERFETTI was in command.

BLAINE ELKINS, son of the late United States Senator Stephen B. Elkins, is said to have done the flying necessary for his elementary pilot's license.

AUGUSTIN PARLA of Cuba, who learned to fly in the United States will soon return to Cuba, taking with him the "John Lansing Callan" silver trophy.

JOSEPH BOQUEL, aviator, fell in a flight at the exposition grounds, San Diego, Cal., November 4, and was killed. This was the last day of his engagement to fly for the exposition. While making a "corkscrew" flight with his airplane Boquel fell 100 feet. The machine came down within the exposition grounds. Guards and spectators hurrying to the spot, found his body badly crushed. Boquel, known as the "Sky Dragon," on account of his spectacular performances, was born in Normandy, France, thirty-two years ago. He leaves a widow and two children.

THE E. B. HEATH AERIAL VEHICLE COMPANY announces that, despite the considerable financial loss incurred through a recent fire in its plant, it has already moved into new quarters at 2846-56 Broadway, Chicago, Ill. The company intimates that it will soon be able to announce some surprising developments.

ALEXANDER BROWN, sportsman cricket player, polo player and aviator, was killed when he fell with his aeroplane into the Delaware River at Essington, below Philadelphia, on October 24. The flight was to have been the last for his license.

ECTOR ORR MUNN of Washington, D. C., is also learning to fly at Marblehead. He is said to be ready to fly alone after less than three hours in the air.

GORDON PRINCE of Beverly Farms and Boston, a brother of Norman Prince recently killed in flying on the front in France, is making rapid progress in flying at the Burgess School at Marblehead. On October 2[illegible] Mr. Prince made four flights with nearly an hour altogether in the air, and with especially rough sea conditions he had no trouble in rising or landing even under these handicaps.

GEORGE C. THOMAS, a well known Philadelphian, has taken his elementary flying [illegible] pilot's certificate at the aviation school at Essington, Pa.

Fahrig Anti-Friction Metal

The Best Bearing Metal on the Market
A Necessity for Aeroplane Service

Fahrig Metal Quality has become a standard for reliability. We specialize in this one tin-copper alloy which has superior anti-friction qualities and great durability and is always uniform.

When you see a speed or distance record broken by Aeroplane, Racing Automobile, Truck or Tractor Motor, you will find that Fahrig Metal Bearings were in that motor.

FAHRIG METAL CO., 34 Commerce St., N.Y.

Factors of Safety

These Count in Aeroplane Construction

NON-INFLAMMABLE

Cellulose Acetate Base

Celestron Cloth Varnishes

provide another SAFETY FACTOR

NON-INFLAMMABLE

Celestron Sheets AND Films

Transparent — Waterproof

MANUFACTURED BY

Chemical Products Company
93 Broad Street Boston, U. S. A.
Manufacturers of Cellulose Acetate for nearly 15 years

Aeroplane Linen

Used by the BRITISH GOVERNMENT in their Air Service; also by the UNITED STATES GOVERNMENT and Large Aeroplane Manufacturers

-o-

Large stocks on hand
Samples and specifications sent on application

Robert McBratney & Company

Linen Manufacturers & Importers
121-123 Franklin Street, New York

For Effective Illumination of Instruments for Night Flying

TREAT YOUR

Compasses
Altimeters
Statoscopes
Clinometers

SEES AT NIGHT

Aneroids
Oil Gauges
Anemometers
Monometers
Clocks

with the only genuine self-luminous compound showing high luminosity at reasonable prices

We will illuminate one of your own instruments without charge if you will send it to us.

RADIUM LUMINOUS MATERIAL CORPORATION
55 LIBERTY STREET, NEW YORK

Sample of material sent on request

COUNTERBALANCED

PARK DROP FORGE COMPANY, Cleveland, Ohio

Aeromarine
Plane & Motor Co.

Aeroplanes and Motors

New York Office: Times Building

Telephone, Bryant 6147

Williams' School of Flying

Extensive New Equipment
Small Classes
Rapid Instruction
Shop Experience in Motor and Plane Construction
Board and Room very Reasonable
Machine Furnished for License Tests
No Charge for Breakage

AL. BOSHEK, Looper,
Instructor in charge

WILLIAMS AEROPLANE CO.
FENTON, MICH.

Don't Scrap Aluminum Parts—Trial Bar 50c

SO-LUMINUM, new welding compound for aluminum, **does away with weak aluminum solders—perfect substitute for acetylene ½ time and cost.** Use gasoline torch. **So-Luminum Mfg. Co., 1790 Broadway, N. Y.**

Courtrai Manufacturing Company's Pure Irish Linen Aeroplane Cloth

Best, Strongest and Lightest on the Market. Large Stock. Immediate Delivery. U. S. and British Government Standard.

Sole Agent in U. S. **115-117 Franklin St., N. Y. City**

Classified Advertising

10 cents a word, minimum charge $2.00, payable in advance. Positions Open or Positions Wanted advertisements, no charge (20 words). Address replies to advertisements with box numbers, care of AVIATION AND AERONAUTICAL ENGINEERING, 120 West 32d Street, New York.

YOUNG ENGINEER, married, experienced machine designer, theoretical and practical aeronautical experience, desires position with reliable company. Address Box 10.

MECHANIC, and student of aviation, can make most any part of an airplane, wants position with some good company. References exchanged. Address Box 11.

FIRST CLASS AERONAUTICAL ENGINEER of wide experience on military airplanes, desires situation as designer, inspector, or director of experiments. Address Box 19.

FOR SALE—Seven cylinder, 70 horsepower rotary motor, with Excelsior propeller. $450.00. Address Landsmann Motor Co., 1406 S. 18th St., St. Louis, Mo.

YOUNG MAN, college graduate, and thoroughly familiar with gas engines, desires position with airpiane company. Best references. Address Box 9.

AGENTS wanted in every city for AVIATION AND AERONAUTICAL ENGINEERING. An especially liberal offer is open for the months of September and October. Address Circulation Managers, AVIATION AND AERONAUTICAL ENGINEERING, 120 West 32d St., New York.

YOUNG MAN doing exhibition work, desires to learn aviation. Address Box 8.

AN EXPERIENCED AVIATOR, who has seen service in France and Belgium, is desirous of establishing a connection with some reliable firm as demonstrator, instructor, etc. Would consider flying for moving picture firm. Experienced in looping, banking and all the tricks of aviation, and not afraid of work in this line. No position considered at less than $600.00 per month. Correspondence confidential. Address Box 42.

EXPERIENCED YOUNG AERONAUTICAL ENGINEER desires position as assistant or in charge of experimental work. Small, live company preferred. Address Box 14.

$635 gets 6-cylinder 85 horsepower Aeromarine motor taken for debt. Identical with motor used by Art Smith. Double oiling system. 2 independent magnetos. In excellent condition; recently overhauled at Aeromarine factory. Address, Box 6.

YOUNG MAN experienced on aerial engines seeks position with reliable concern manufacturing Aircraft. Wants instruction in flying. Address, Box 47.

GENERAL AERONAUTIC COMPANY

A New Jersey Corporation

MANUFACTURERS OF

Monoplanes **Biplanes**

Sea Planes **Flying Boats**

Aeronautical Engines

New York Office
110 West Fortieth Street
NEW YORK CITY, N. Y.

Main Office of the Company
Trust Company Building
BLOOMFIELD, N. J.

ONE YEAR—24 ISSUES—ONE DOLLAR

AVIATION AND AERONAUTICAL ENGINEERING

The 24-Part COURSE IN AERODYNAMICS AND AEROPLANE DESIGN, by the Instructors in Aeronautics in the Massachusetts Institute of Technology.

SPECIAL TECHNICAL ARTICLES written by the leaders in the Profession on Every Phase of AERONAUTICAL PROGRESS.

POPULAR AERONAUTICAL ARTICLES in Every Issue, Illustrated by the BEST PHOTOGRAPHS and LOTS OF THEM.

All the REAL NEWS of the Industry and of the Aviators presented in Condensed and Attractive Form.

The Doings of the AERO CLUBS and all the FEDERAL and STATE MILITARY and NAVAL NEWS.

By sending one dollar to-day you can secure the full course beginning with the first part.

THE GARDNER, MOFFAT COMPANY

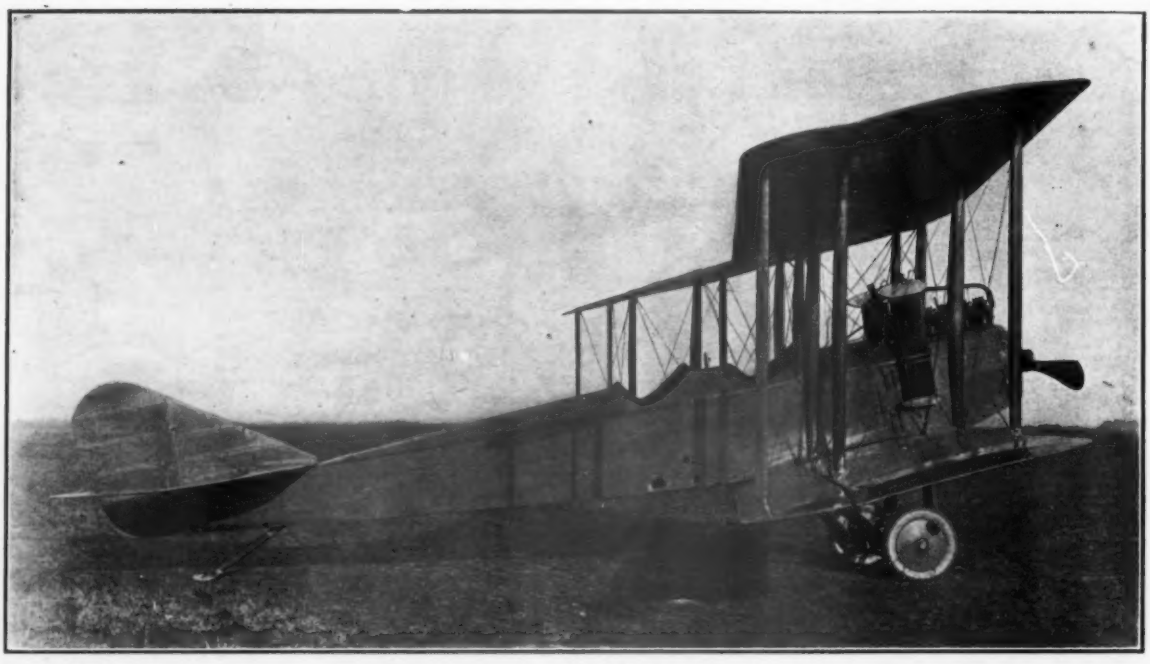
120 West 32d St., New York

THE WILLIAMS PRINTING COMPANY, NEW YORK

STANDARD

AEROPLANES AND HYDROAEROPLANES

CHAS. H. DAY, *Designer*



THE STANDARD MODEL H 3 TRACTOR

Army and Navy orders now being filled as the result of official inspection of factory and products

STANDARD TRACTOR BIPLANES
STANDARD HYDROAEROPLANES

Single and Twin Motored Types offered on the basis of results and not expectations

STANDARD AERO CORPORATION
OF NEW YORK

EXECUTIVE OFFICES
Woolworth Building, New York

FACTORY
Plainfield, New Jersey